Opportunities for transition to clean household energy in Kenya

Application of the WHO Household Energy Assessment Rapid Tool (HEART)

Gladys Ngeno
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World Health Organization

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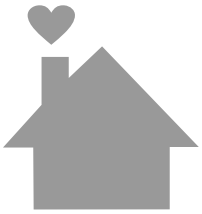

KENYA

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Contents

Abbreviations and acronyms

GDP	gross domestic product
GIZ	German Corporation for International Cooperation
HAP	household air pollution
HEART	Household Energy Assessment Rapid Tool
KES	Kenyan shilling
WASH	water, sanitation and hygiene

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Preface

Household air pollution (HAP) from inefficient fuel combustion is one of the most important global environmental health risks today. Almost 3 billion people, mainly in low- and middle-income countries, still rely on solid fuels (wood, animal dung, charcoal, crop wastes and coal) burnt in inefficient, highly polluting stoves for cooking and heating. Widespread use of polluting cookstoves causes almost 4 million premature deaths annually among children and adults from respiratory illness, cardiovascular diseases and cancer, as well as serious injuries from scalding, burns and poisoning.[1]

The WHO guidelines for indoor air quality: household fuel combustion (2014) provide technical recommendations for policy-makers and specialists working on energy, health, environmental and other issues to ensure health benefits from the clean energy transition.

In support of the implementation of the guidelines, WHO has developed a tool, the Household Energy Assessment Rapid Tool (HEART), to identify relevant stakeholders, and map out a country's policies and programmes on household energy and/or related health impacts. The tool is being pilot-tested as a guide to conducting rapid situational assessments of countries' readiness to address access to clean energy technologies. It is used to gather and synthesize information on household energy use and its public health impacts and to stimulate an informed dialogue on the impacts of household energy interventions, shared responsibilities and coordinated actions, country-specific barriers to implementation and opportunities for the public health sector to accelerate a transition to clean household energy.

The rapid assessments do not take the place of the detailed economic evaluations required to identify national energy priorities, national and global work on mapping disease incidence nor the social and political considerations required in implementing major social interventions in public health. They do provide a broad overview of the current household energy and health situation, identify key stakeholders and will ultimately support intersectoral cooperation. This report presents the results obtained with HEART in Kenya.

1 https://www.who.int/airpollution/data/HAP_BoD_results_May2018_final.pdf?ua=1

1 Introduction

There is no "one size fits all" approach to successful clean household energy initiatives. A suite of options targeted to different sociocultural environments is likely to have wider acceptance. There are nevertheless some common factors in effective efforts: large-scale initiatives with targeted messaging and market development; financing mechanisms for both end-users and distributors, assured product quality, enabling policy and regulatory environments, coordination with social welfare programmes and public–private partnerships for scaling up.

A transition to clean fuels in Kenya will require work in several areas. In many parts of the country in which fuel is purchased, especially urban and peri-urban areas, the cost of clean household energy is competitive with that of solid fuels and kerosene. In these areas, a direct transition to clean technologies is feasible, and promotion of slightly improved transitional technologies (such as improved biomass stoves) would be counterproductive.

Media campaigns to dispel myths about clean fuels are an important means for changing the national dialogue and building successful markets for clean cooking fuels. Cultural perceptions (including myths about the flavour of food cooked on traditional stoves and the relative safety and cost of clean alternatives) remain a significant barrier to wider uptake of clean cooking fuels. Although information to refute such beliefs is available locally, it is not widely disseminated.

A national strategy should be prepared, coordinated by interministerial partnerships and based on internationally recognized priorities (similar to international coordination on water, sanitation and hygiene (WASH)), to promote and deliver clean energy. Currently, overlapping mandates and weak interagency cooperation are barriers to operationalizing the Kenya Sustainable Energy for All (SE4All) Action Plan (1), which sets an ambitious target for universal access to modern energy by 2020. County-level action plans will also be important in increasing access to clean fuels. Proposed expansion of liquefied petroleum gas (LPG) networks will provide opportunities to increase market penetration at scale.

Rapid progress in grid densification and distributed electricity solutions (mini-grids and stand-alone systems) is likely to result in the transition of most Kenyan households to clean lighting fuels; however, changing the demand for cooking fuels, which are typically firewood, charcoal and kerosene, has been more difficult. Adaptation of financial models and using lessons learnt from successful market development and large-scale penetration of solar home products may result in wider uptake of clean cooking fuels.

Better local evidence on the benefits of clean household energy will engender greater support from policy-makers. More research funding from the Kenyan Government will make it possible to improve policy modelling and estimates of disease burden. In addition, robust evidence on the synergies and trade-offs among universal access to health care, mitigation of climate change, access to energy and broader development goals will allow all stakeholders to make consistent, systematic priorities. Using clean household energy to accelerate achievement of social welfare targets for low-income populations, the elderly, children and women will increase penetration by approaches that are not based on the market.

Targeted funding committed by donors and from public finance, especially to develop common information and raise nationwide awareness about clean fuels, will help to achieve clean household energy for all.

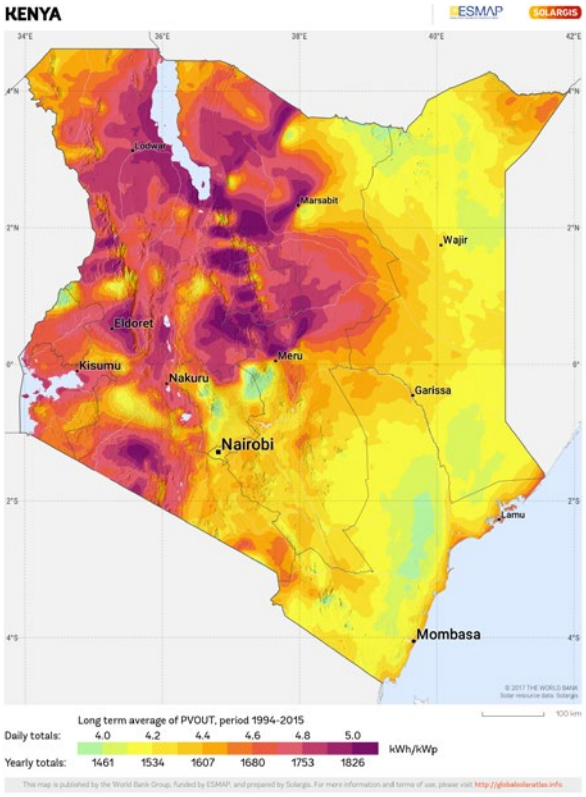
2 Country context

2.1 Geographical data

Kenya is located across the equator, stretching from latitudes 4° N to 4° S and longitudes 34–41° E, covering an area of approximately 582 646 km^2 (Fig. 1). In favourable regions, global horizontal irradiation is ≤ 2400 kWh/m^2 per year.

↑ ***Fig. 1.*** *Topological map of Kenya*

Source: Kenya Meteorological Department



↑ ***Fig. 2.*** *Global horizontal irradiation, Kenya*

© 2016 The World Bank. Solar resource data: Solargis (https://solargis.com/maps-and-gis-data/download/kenya).

2.2 Demographic and economic data

2.2.1. Population distribution

The population at the end of 2014 was estimated to be 45.56 million, up from 38.6 million reported in the Population and Housing Census in 2009 (2). The age distribution differs in rural and urban areas (Table 1).

↓ ***Table 1.*** *Population distribution by age range, Kenya, 2009*

Population	Age (years) (%)			
	0–14	15–34	15–64	≥ 65
Rural	46.1	31.8	49.8	4.1
Urban	36.5	42.4	61.3	2.2
National	43.0	35.0	53.4	3.5

Source: reference 2.

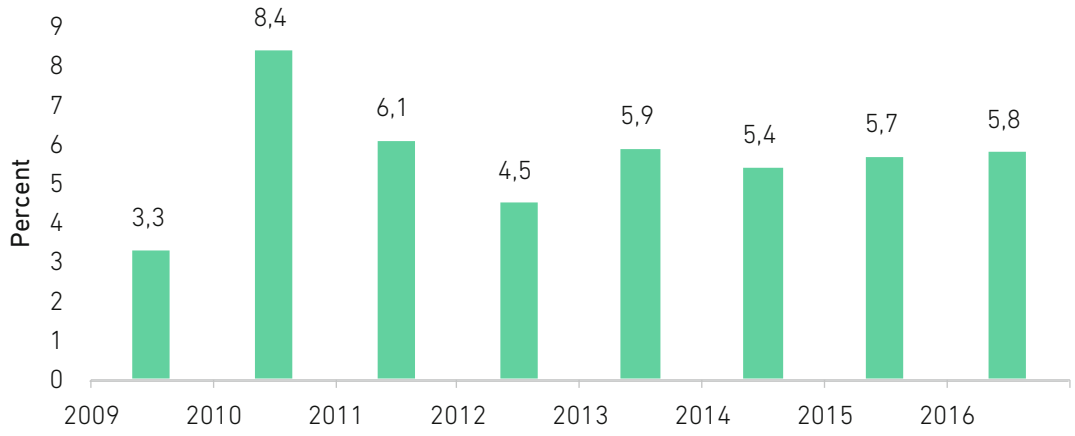
As 78% of its population is under 35 years of age, and 60% of the labour force are aged 18–35 years, Kenya's national strategic plans should take into account the central role of youth in accelerating access to clean household energy. In view of the large population of children and elderly people in rural areas, clean household energy should be seen as essential for social protection and vulnerability reduction in rural areas.

2.2.2. Urbanization

Kenya has an urbanization rate of 4.3%, and about 27% of its population live in urban areas (3). The accumulated housing deficit is estimated at over two million units, and nearly 61% of urban households live in slums (4).

2.2.3. GDP growth

With a gross domestic product (GDP) of US$ 61 billion and a GDP growth rate of 5.8% (Fig. 3), Kenya is one of the largest economies in sub-Saharan Africa; in 2015, it achieved middle-income country status (4). Access to competitively priced, reliable, good quality, safe, sustainable energy is essential for the achievement of Kenya's Vision 2030, the national development blueprint (5).

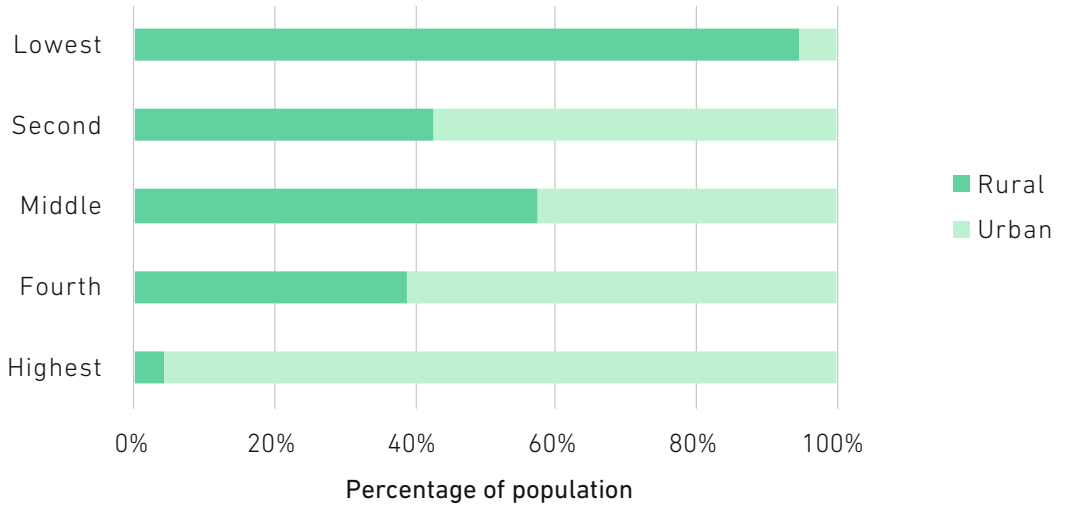


↑ ***Fig. 3.*** *Growth in gross domestic product, Kenya, 2009–2016*

Source: Compiled from Kenya Economic Surveys 2010–2017, Kenya National Bureau of Statistics (https://www.knbs.or.ke/publications/).

The estimated wealth disparity in 2016 was 47.7% (6). Kenya's population is dispersed over 47 counties with significant differences in wealth, which complicate the introduction of clean household energy. Most of the disparity is due to the disproportionate poverty in rural areas (Fig. 4). Thus, 90% of Kenyans in the bottom 40% of the income distribution live in rural areas (6).

Only 23% of households in Kenya use electricity for lighting. A household in Nairobi is 36 times more likely to have electricity for lighting than those in Tana River (2.4% coverage) and Turkana (2.2% coverage). Urban areas have 10 times more electricity coverage (51%) than rural areas (5%). Almost 10 times more people in urban than in rural areas spend ≥ 7200 KES on electricity (7).



↑ ***Fig. 4.*** *Urban and rural populations in Kenya, by wealth quintile*

Source: reference 8.

2.3 Infrastructure

2.3.1. Roads

The condition of the roads in Kenya is a real barrier, especially in remote places, which limits "last-mile" distribution. In 2013, Kenya had a total rural road network of 136 374.92 km, of which 90% were unpaved. A survey of the condition of the road network undertaken by the Kenya Roads Board in 2013 (9) showed that 39% of the rural road network was good, 36% fair and 25% poor (Table 2).

↓ ***Table 2.*** *Condition of rural roads in Kenya, 2013*

	Good		Fair		Poor		Total	
	km	%	km	%	km	%	km	%
Paved	1 903	1.73	1 189	0.75	872	0.57	3 964	9.91
Unpaved	41 047	37.27	55 613	35.25	37 075	24.43	132 411	90.09
Total	42 950	39.00	56 802	36.00	37 947	25.00	136 375	100.00

Source: reference 9.

2.3.2. Electricity

Kenya has made impressive progress in electrification, from 23% coverage in 2009 to about 50% in 2016, with grid densification. During the past 6 years, the number of customers (both total and domestic) tripled, at an annual average increase of 20%. Since financial year 2012–2013, the number of new connections has nearly doubled each year, and the target for 2022 is 100%, with both grid and off-grid solutions. In the next 5 years, starting in 2016, the Government target is a connectivity rate of 1 million customers per year.

The increased electrification is characterized, however, by uneven connectivity (7):

- The population living in the Nairobi area accounts for 25% of the national population but 50% of access to a power supply and 50% of the consumption of electricity.
- Nine of the 47 counties are considered to be off-grid: Marsabit, Turkana, Mandera, Wajir, Lamu, Tana River, Isiolo, Garissa and Samburu.
- Kenya's grid is concentrated almost exclusively in the central corridor, where the population density is highest.
- Regions not covered by the national grid rely on isolated grids mainly fuelled by fossil fuels, small diesel-fired generators or electricity substitutes such as kerosene lamps.

2.3.3. Health services

In 2013, administration of primary and secondary health services was changed from the national Government and the Ministry of Health to the county governments. The Ministry of Health provides support and technical guidance to the counties and is responsible for regulating the health sector and ensuring that the counties provide health services. The Ministry is guided by the Kenya Health Sector Strategic Plan 2013–2017 (10). Kenya's health care system is hierarchical, with six tiers (11): tier 1 is the community; 2 is dispensaries; 3 is health centres; 4 is sub-county hospitals, which are the primary referral facilities; tier 5 are county hospitals, which a secondary referral facilities; and tier 6 is national hospitals, which are tertiary referral facilities. Tiers 1–5 are administered by county governments and tier 6 by the national Government.

2.3.4. Communications

Information and communication technology plays a large role in the services sector, contributing 4.1% of added value. Mobile phones are used by 90.4% of the population (41 028 000) (12), and the numbers of Internet users and mobile money subscriptions are rising (Table 3). Mobile payments reduce the cost of money transfers, provide extended access to finance for rural households and are a source of employment.

↓ ***Table 3.*** *Use of information and communication technology, Kenya, 2017–2018*

No. of mobile phone subscriptions	41 028 000
Mobile phone penetration (%)	90.4
No. of mobile phone money subscriptions	28 192 000
No. of registered mobile phone money agents	184 537
No. of data and Internet subscriptions	30 891 000
Number of free-to-air television channels	62
No. of FM radio stations	178
Population covered by digital signal (%)	83.6
No. of data users	51 100 000
Internet penetration (%)	112.7[a]

Source: reference 12.

a Calculated as the total no. of data users (about 51 million) as a percentage of the national population of about 45 million. The Authority is reviewing the method for estimating Internet penetration in line with current market developments and international standards.

The robust communication infrastructure presents opportunities for scaling up "pay as you go" for financing, monitoring adoption and use of clean household energy technologies and conducting consumer awareness and behaviour change campaigns.

2.3.5. Education

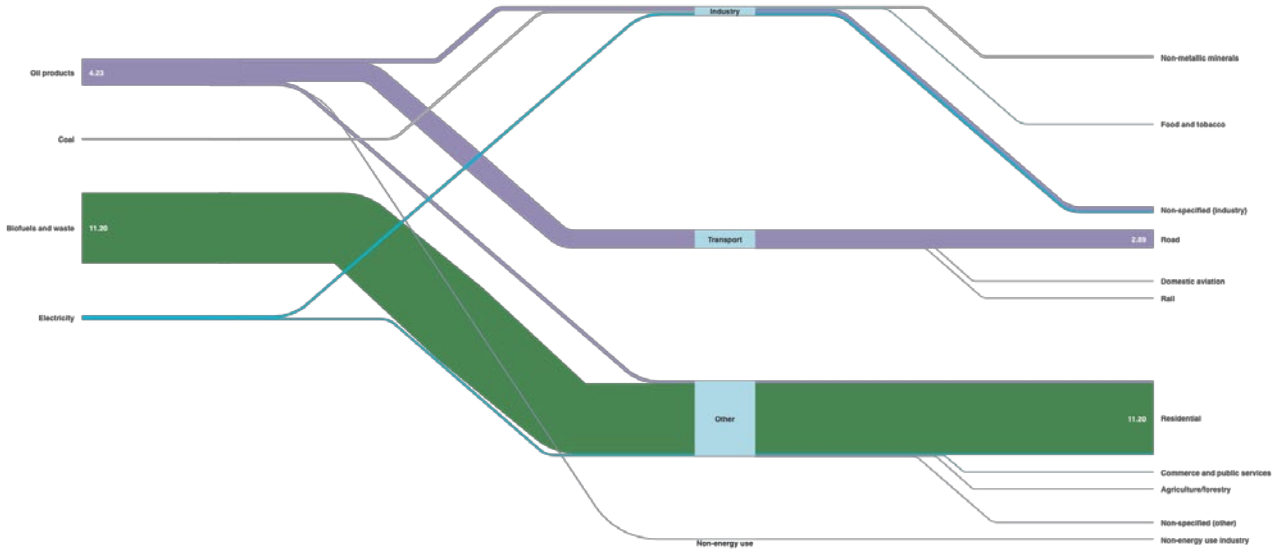
Education is the best-distributed social service in Kenya, with an educational institution in every village and many schools (mostly private) in informal settlements. Both the national and county

governments are improving the infrastructure as part of education reform. Educational institutions are essential for raising awareness and could be used to accelerate access to clean household energy.

Some of the main school energy projects are the school electrification programmes of the Rural Electrification Authority and the "green schools" project, which promotes the establishment of woodlots, increases awareness about energy and installs efficient stoves in school kitchens.

2.4 Energy production and consumption

At present, electricity accounts for only 9% of the total energy use in the country, petroleum products for 22% and renewable energy (mainly biomass) for 69%. Residential cooking, heating and lighting are powered almost exclusively by biomass (Fig. 5). The small share of electricity is due mainly to low, uneven connectivity in the country (13). Only about 30% of domestic consumers contribute to total consumption, although they account for 90% of connections. Growth in electricity use between 2011–2012 and 2016–2017 is shown in Table 4.



↑ ***Fig. 5.*** *Fuel consumption by sector, Kenya, 2015*

Source: reference 14.

↓ ***Table 4.*** *Electricity demand and consumption, 2012 and 2017*

Year	Energy generated (GWh)	Energy sold (GWh)	Peak demand (MW)	No. of consumers
2011–2012	7 670	6 341	1 236	2 038 625
2016–2017	10 115	8 272	1 656	6 182 282

Source: reference 15.

Envirofit stove
Credit: Nigel Bruce

3

Health sector data

3.1 Burden of disease

Kenya's burden of disease has been due mainly to communicable diseases such as AIDS, respiratory infections, malaria and tuberculosis; however, the prevalence of noncommunicable diseases such as cancers and cardiovascular diseases is increasing rapidly. This is attributed mainly to the growing middle class, urbanization, rising consumption of fast foods and an increase in sedentary behaviour. Injuries are the third contributor to the burden of disease, due mainly to road accidents along major highways (9).

Several health outcomes have been improved in the past few decades, with increased use of health services. The child mortality rate fell significantly, by nearly a third, in the period 2003–2012, and the burden of major communicable diseases has been reduced during the past decade (16). The number of children who were fully vaccinated increased by 10% between 2003 and 2008, from 57% to 68% (16).

Communicable diseases and maternal and perinatal conditions continue to predominate; however, hospital data suggest that noncommunicable diseases account for 50–70% of hospital admissions and are responsible for up to 50% of inpatient mortality (16). It is projected that, by 2027, noncommunicable diseases will be the main cause of ill health in the country (18).

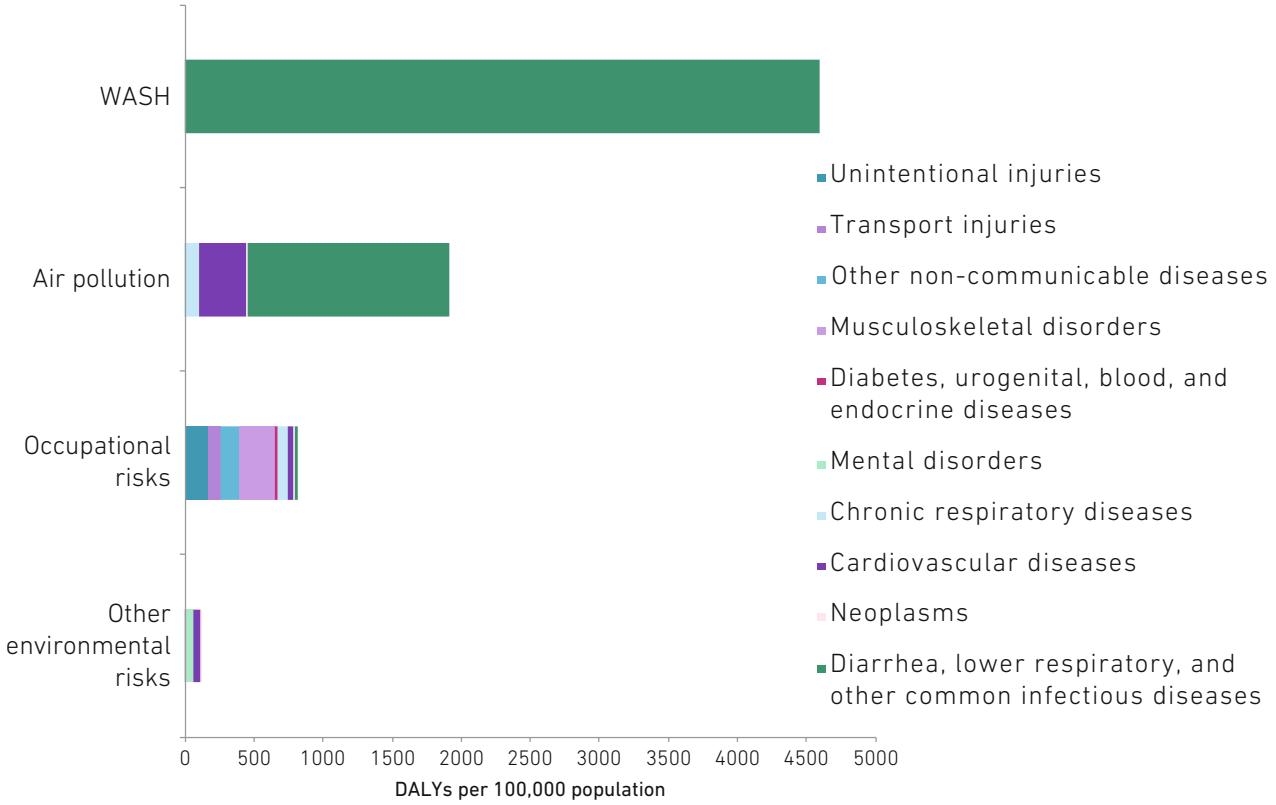
Table 5 shows the main causes of morbidity in Kenya between 2010 and 2014.

↓ ***Table 5.*** *Main causes of morbidity, Kenya, 2010–2014*

Cause	2011 Percent of total (%)	2012 (%)	2013 (%)	2014 (%)
Diseases of respiratory system	27	29	40	42
Skin diseases	7	8	10	11
Pneumonia	3	3	3	4
Rheumatism	2	2	2	3
Urinary tract infection	2	2	3	3
Accidents	2	2	2	3
Typhoid	2	2	2	2
Hypertension	1	1	1	2
Others	27	26	34	39

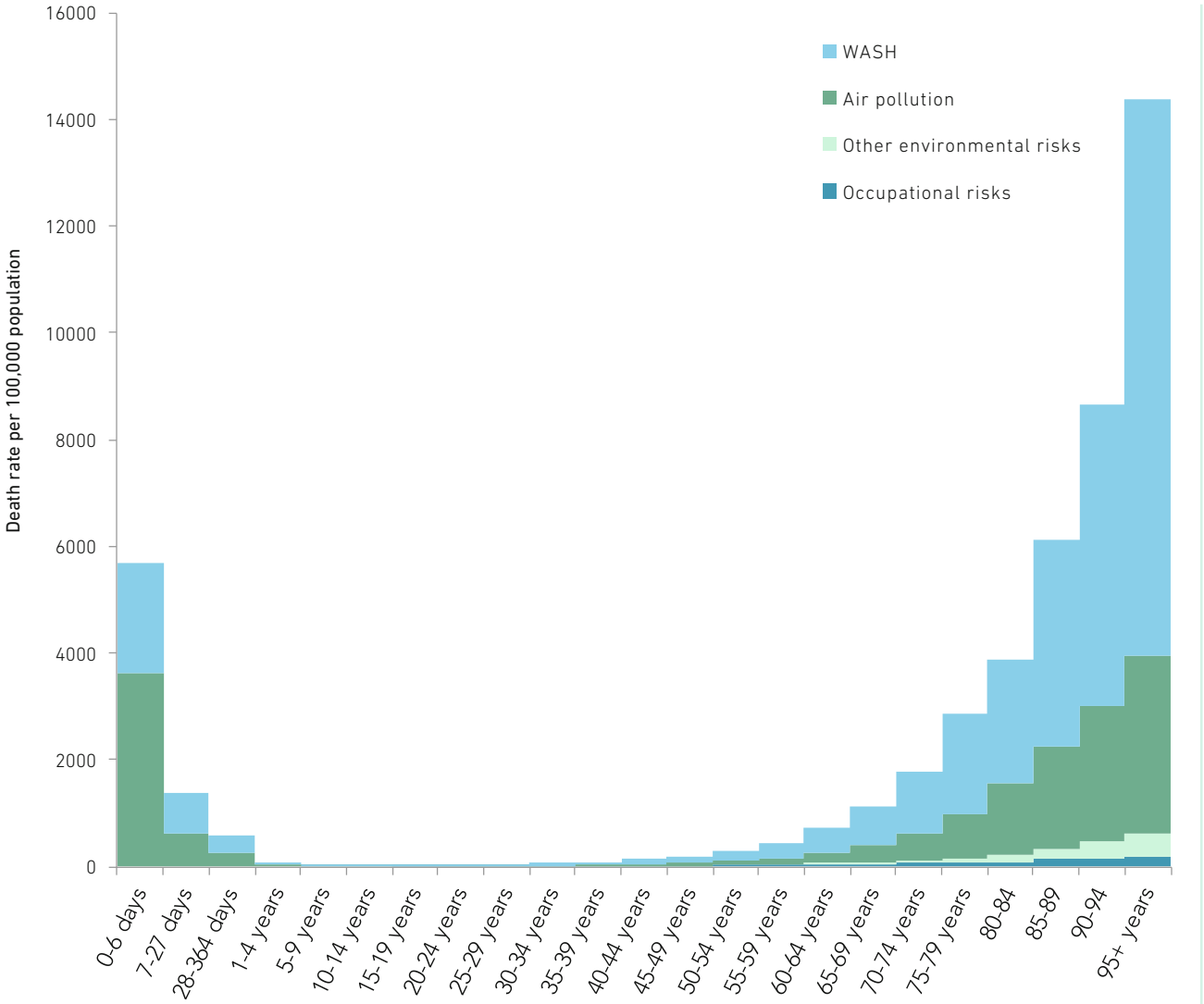
Source: reference 19.

Fig. 6 shows the disability-adjusted life years lost according to environmental risk factors for the Kenyan population in 2016, and Fig. 7 illustrates the numbers of deaths due to those factors by age group.



↑ ***Fig. 6.*** *Disability-adjusted life years (per 100, 000 population) lost due to environmental risk factors, Kenya, 2016*

Source: reference 20.



↑ ***Fig. 7.*** *Death rate (per 100,000 population) due to environmental risk factors by age group, Kenya, 2016*

Source: reference 20.

Acute respiratory infections, often caused by household air pollution (HAP), are in the top five leading causes of death in the country and some estimates show over a quarter of all deaths in Kenyan hospitals (21). The main groups affected are women and children in households in which open fires are used in built-in kitchens, cooks and kitchen helpers in institutions and secondary school students who use kerosene lamps while studying (22). It has been estimated that HAP causes 15 140 premature deaths each year (17), which is five times the national death toll from road accidents. Pneumonia accounted for increasing numbers of cases of upper respiratory infections over the past 9 years.

3.2 Health sector policies and programmes to address air pollution

Article 42 of the Kenyan Constitution gives each citizen the right to live in a clean, healthy environment. With respect to HAP, it is the responsibility of the Ministry of Health to:

- formulate policies, guidelines and regulations;
- build capacity at all levels of the health service to manage exposure to HAP and its consequences;
- integrate management of exposure to HAP and its consequences into programmes such as community strategies, HIV/AIDS and WASH;
- raise awareness about the dangers of HAP; and
- ensure reporting in order to quantify the impact of air pollution.

The Kenyan Government recognizes the health effects of HAP and is increasing the supply of improved cooking stoves in 14 counties with development partners, including the German Corporation for International Cooperation (GIZ), the Clean Cookstoves Association of Kenya and Population Services Kenya. Preliminary studies indicate, however, that the improved cookstoves do not significantly reduce HAP (24). Other projects include the World Bank Kenya off-grid solar access project and a biogas project with the Ministry of Energy and Petroleum and the Netherlands Development Organisation (SNV). Stakeholder organizations are listed in Annex 1.

The Ministry of Health has no current policy on HAP and health, although HAP is being integrated into the current revision of strategic documents and policies.

- The second Health Sector Strategic Plan, 2013–2017 (10), listed HAP as the fifth risk factor targeted for containment. In the third revision, the issue of HAP is included under environmental health.
- Part 9 of the Environmental Health and Sanitation Bill prohibits pollution of watercourses, soil and air and noise pollution. It also prohibits open defecation. It further establishes a duty for owners or occupiers of premises or land to arrange for removal of litter. The Environmental Sanitation Bill, submitted to Parliament for approval, includes aspects of HAP under "Nuisance management".
- The National Environment Management Authority issued Air Quality Guidelines in 2014, which include management of HAP and housing in the informal sector.
- The Noncommunicable Diseases Strategic Plan 2017–2020 (18) states that most of these diseases are linked to pollution and lifestyle. The Plan includes an investment module, which will address HAP.

Programmes for vaccination and nutrition, which contribute to mitigating the effects of HAP, are summarized in Annex 2.

3.2.1. Environmental health risk assessments

The Institute of Health Metrics and Evaluation assessed disease trends and ranks in 2016 (25). Environmental and occupational risks are responsible for many diseases, and air pollution is the second most prevalent environmental risk factor for premature death and disability-adjusted life years in Kenya. Deaths among children attributable to HAP are dominated by lower respiratory infections, with the highest incidence in the first six days of life (see Fig. 7). The reduction of exposure during pregnancy and during the first 2 years of life should be a high priority.

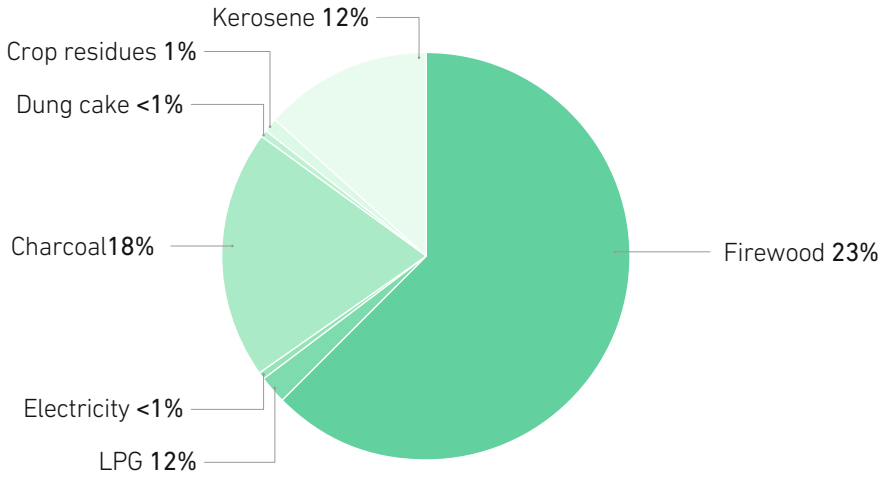
Wind wheel at Tsavo East National Park, Kenya
Credit: Getty images

4

Household energy use

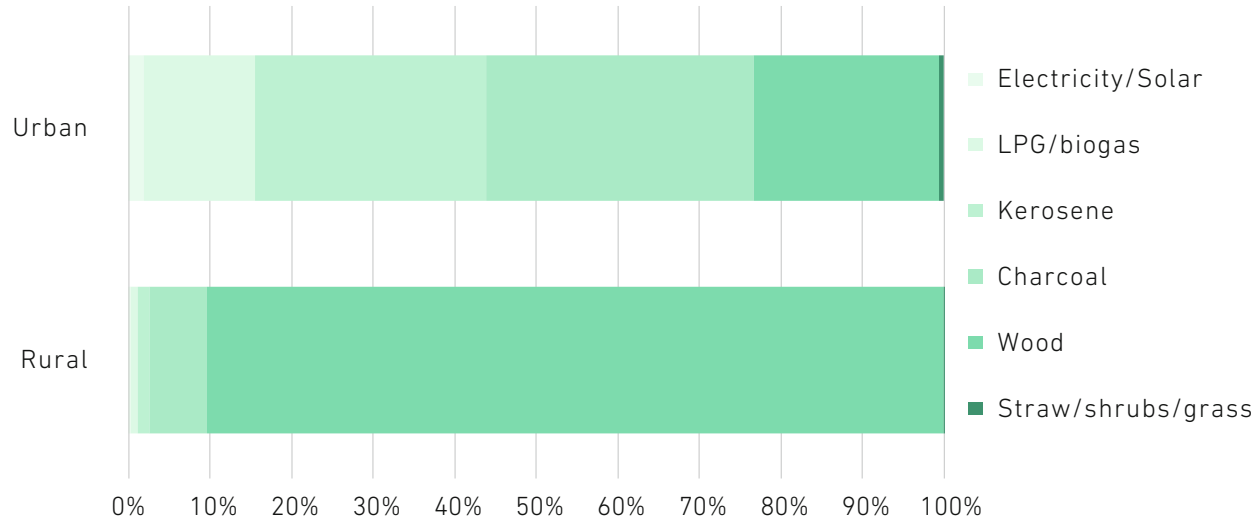
4.1 Energy used for cooking

Current household fuel use is summarized in Annex 3. In the overwhelming majority of rural households, firewood is the principal cooking fuel, with some use of charcoal; in urban areas, households use charcoal, LPG or kerosene (Fig. 8). Overall, 73% of the population live in rural areas, and 96% of them cook mainly with solid fuels or kerosene; while of the 27% who live in urban areas, 45% cook mainly with solid fuels or kerosene (Fig. 9). LPG has some penetration in urbanized areas and in the western half of the country.



↑ ***Fig. 8.*** *Cooking fuels used in urban and rural areas, Kenya, 2014*

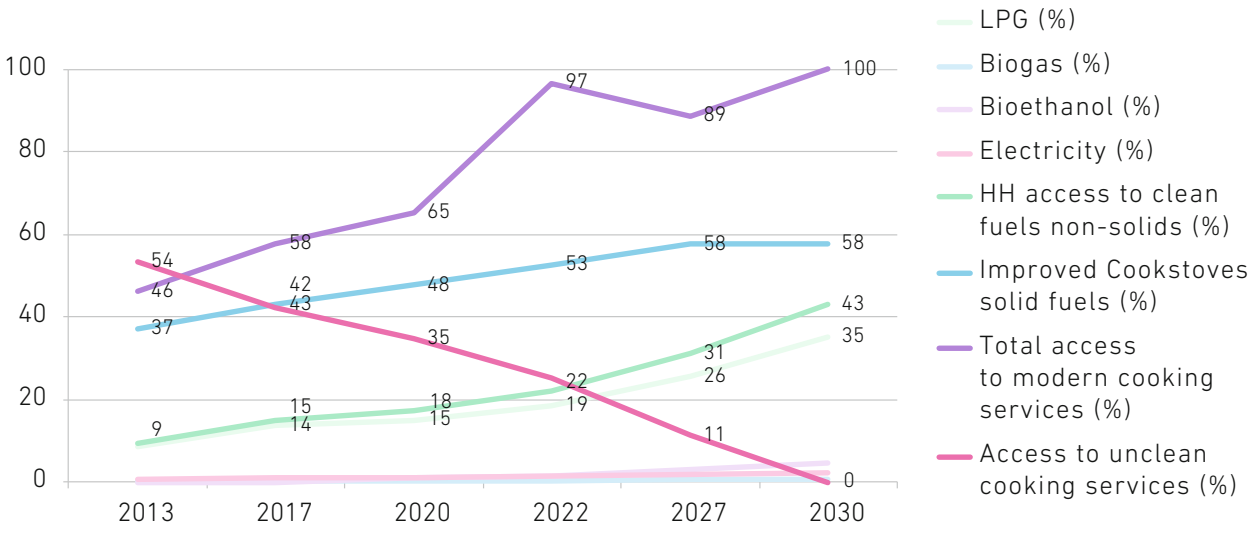
Source: Reference 8.



↑ ***Fig. 9.*** *Cooking fuels used in urban and rural areas, Kenya, 2014*

Source: reference 8.

Despite a gradual trend towards cleaner modern fuels as incomes rise, an estimated 54% of the population use several fuels to reduce the effect of price volatility and fuel shortages (26). There has been a marginal change in the mix of cooking fuels over the past 17 years. To ensure a substantial, long-term impact, clean household energy initiatives must transform the national dialogue. The draft National Energy and Petroleum Policy 2015 (27) set the target of changing 22% of Kenya's households to cooking with clean non-solid fuels (18.6% LPG) over the following 5 years. It also projects the use of improved cookstoves with solid fuels by 52.7% of households by 2022 (Fig. 10). In view of the past rate of change, achieving the projections will require transformative shifts in policy.



↑ ***Fig. 10.*** *Projected growth in clean household cooking energy by 2030*

Source: reference 1.

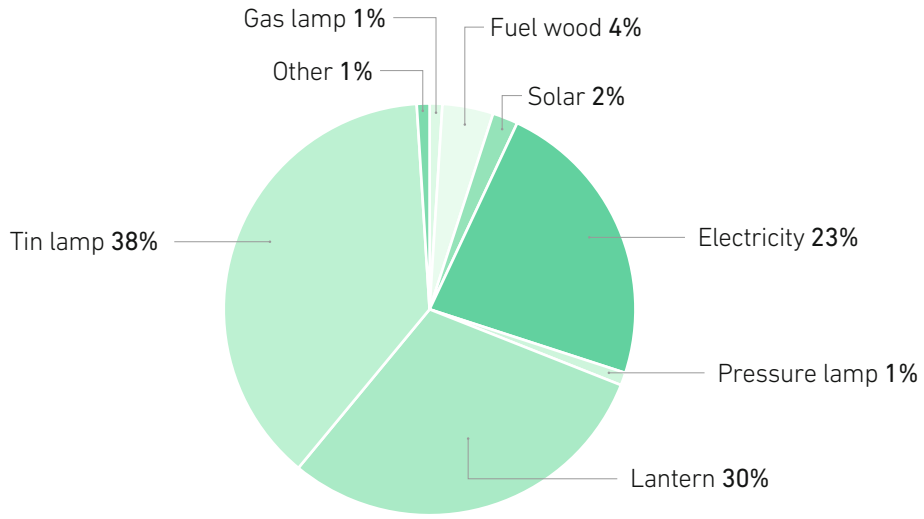
LPG, liquefied petroleum gas; HH, household

4.1.1. Cooking location

According to the 2014 Kenyan Demographic Health Survey (8), 50% of households cook inside the home, 42% cook in a separate building, and 7% cook outdoors. The percentage of households that cook within the dwelling is much higher in urban areas (77%) than in rural areas (30%). More than 90% of households in Nairobi's Korogocho and Viwandani slums cook in the room in which they live and sleep (28).

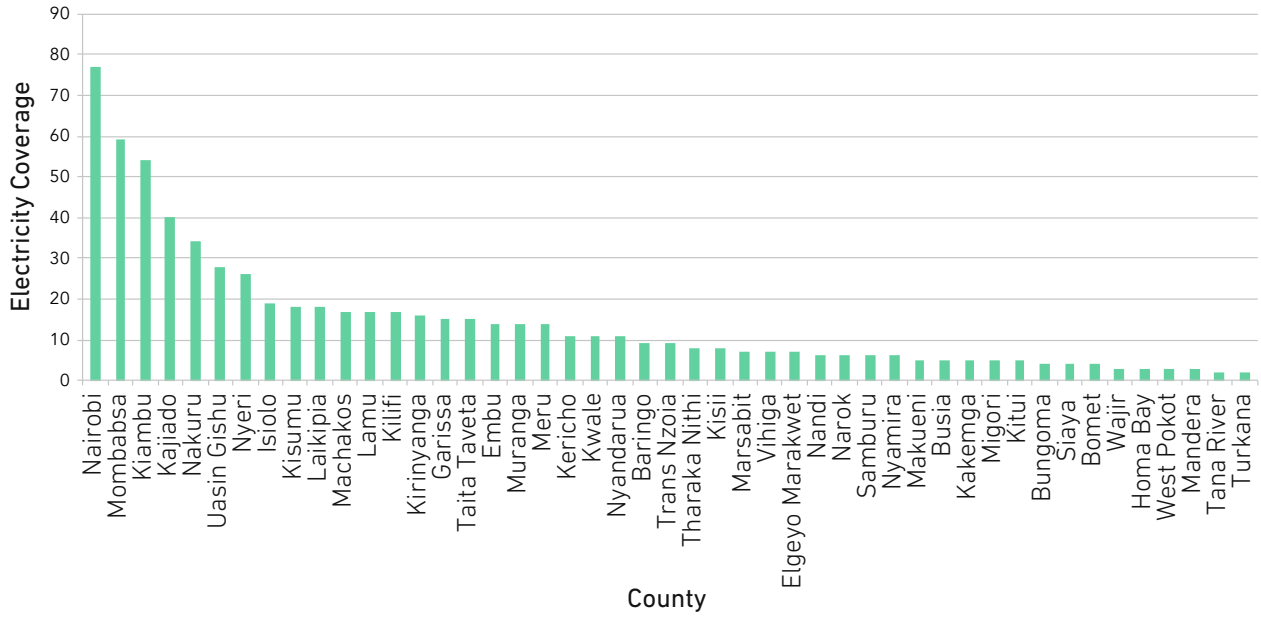
4.2 Energy used for lighting

Kerosene is the most common lighting fuel used in Kenya (Fig. 11), accounting for 69% nationally and 84% in rural areas. Electricity is used for lighting in 23% of households nationally and in 51% of urban households (8). There is wide disparity in electrification by county: a household in Nairobi is 36 times more likely to have electricity for lighting than a household in Turkana or Tana River County (Fig. 12).



↑ ***Fig. 11.*** *Fuel used for lighting, Kenya, 2014*

Source: reference 8.



↑ ***Fig. 12.*** *Electricity coverage by county, Kenya, 2009*

Source: reference 6.

Charging mobile phones at village power centre in Kiangombe, as part of project to eliminate kerosene from home lighting by substituting it with Light Emitting Diode (LED) lanterns

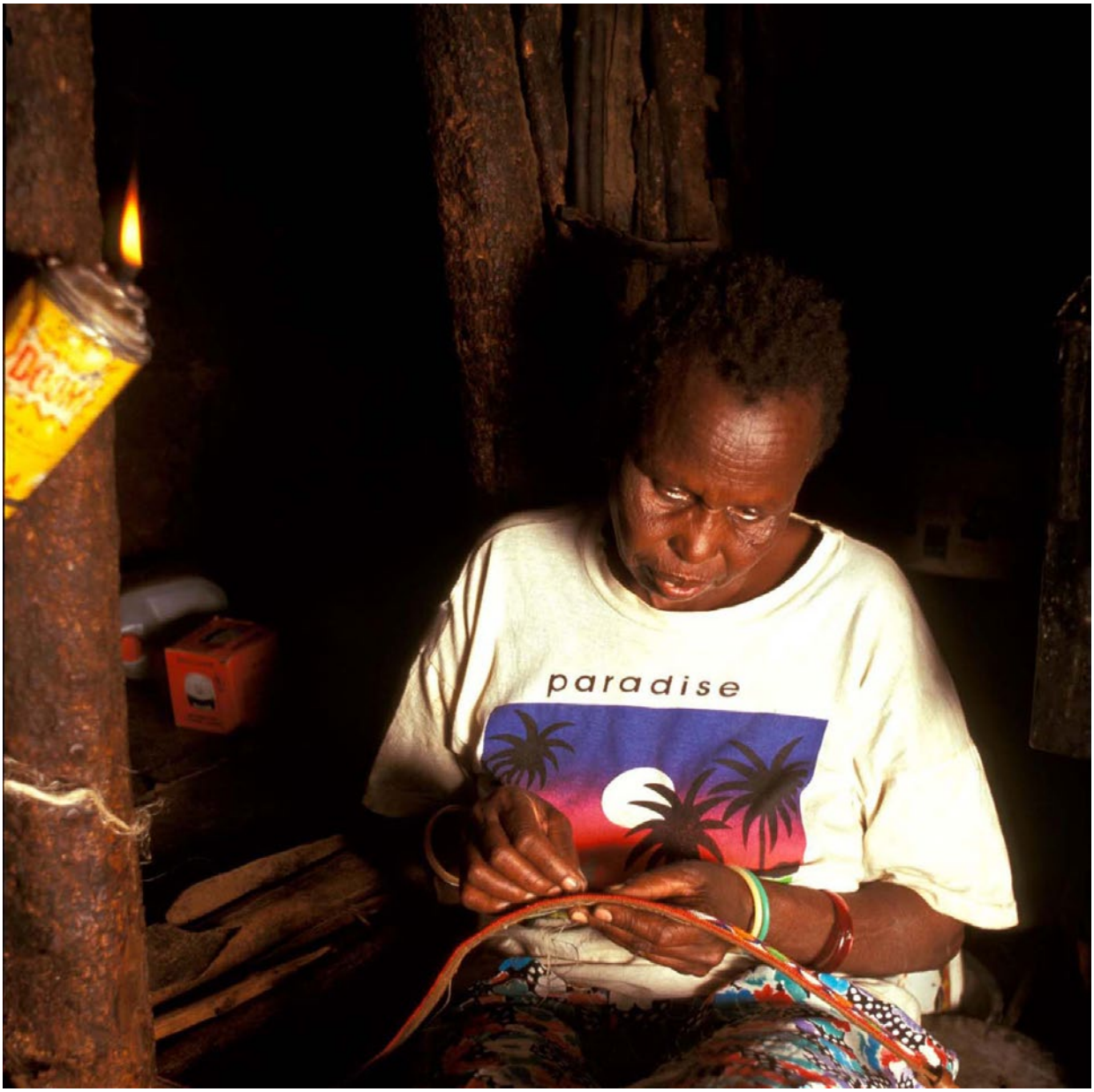
Credit: Simon Maina / AFP / Getty Images

4.3 Energy used for heating

Although there is little information on the population's requirement for space heating in Kenya, highland populations use energy for heating, particularly during the rainy seasons. In addition, populations with separate kitchens in highland areas frequently also use charcoal stoves to warm living areas and to make morning tea (29), with associated risks due to elevated carbon monoxide concentrations.

4.4 Safety of household energy

Over ninety per cent of burn deaths occur in low- and middle-income countries (30), and the high incidence suggests that such injuries contribute more significantly than previously thought to morbidity in these countries. In a prospective, population-based disease surveillance study in 6000 households in the urban slum of Kibera in 2006–2011, the overall incidence of household burns of any severity was 27.9/1000 person–years of observation, which was 10 times higher than in most other published reports from Africa and Asia. Children aged less than 5 years sustained burns at rate 3.8 times that of people aged more than 5 years ($P < 0.001$). The rate of burns among females aged ≥ 5 years old was 1.35 times that of males of the same age distribution ($P < 0.001$) (31). Burns and scalds represented 14.3% of all reported household injuries in 200 rural and 230 urban households in four rural villages and five urban clusters in Kiambu District, Kenya (32).



Beadwork by kerosene lamp
Credit: Nigel Bruce

5

Social interventions

5.1 Social welfare programmes

In 2013, the Government established a national "safety net" programme to ensure a coordinated, harmonized framework for the five main cash transfer programmes: for orphans and vulnerable children, for people with severe disabilities, for the elderly, as an urban food subsidy and the "hunger safety net" programme. More than 500 000 households regularly receive cash transfers, and an additional 374 806 households in northern Kenya receive cash assistance in the case of extreme weather events. Clean household energy interventions could be introduced into the programme to change the fuel used for cooking in these vulnerable households to clean energy, which would position clean household energy as a means of reducing poverty and vulnerability. A baseline study should be conducted to determine the contribution of household energy to improving the welfare and resilience of beneficiaries, current household energy use in vulnerable households and the approaches that could be used to include clean fuels in cash transfers.

5.2 Youth empowerment programmes

Young people are at the epicentre of the Government's transformative agenda, as 78% of the population is under 35 years of age (33). The Government has made youth empowerment a flagship project in its Vision 2030 medium-term plan, as, in the long term, the effects of exposure to HAP will affect the health and economic productivity of this crucial labour force. Access to clean household energy should therefore be integrated into youth empowerment programmes. Possible initiatives include:

- a study on youth engagement in promoting access to household energy (e.g. number of youth-led energy enterprises, training in household energy) and the gaps and opportunities for optimal engagement, to provide the basis for establishing a "youth empowerment for sustainable energy" programme;
- including clean household energy into economic empowerment programmes such as the Youth Enterprise Fund and the proposed national internship programme; and
- involving young people in the development and design of awareness campaigns about HAP.

5.3 Housing programmes

Reducing HAP requires addressing the entire cooking environment and not just changing cooking fuels and stoves. A national "clean kitchen" project would align clean household energy with other projects, such as WASH (water for cooking and washing utensils) and the design and construction of appropriate chimneys and cabinets. Clean cooking techniques could also be integrated into mass-housing programmes, such as slum upgrading, police and military housing and the Government's project to build one million houses, which would demonstrate the Government's commitment and empower each group. Design guidelines and manuals for constructing modern kitchens in rural settings and informal urban settlements would promote good practice.

5.4 Women's groups

More emphasis should be placed on working with women's groups in view of their growing influence on behaviour, their ability to self-finance household items through group guarantees for loans and their past success in financing other products. The benefits of economies of scale could be extended by bulk buying and installment payments to accelerate adoption of clean fuels by households with low purchasing power.

A woman cooking dinner.
Credit: Andrzej Kubik / shutterstock

6 Discussions and recommendations

The barriers listed in Table 6 should be addressed to increase penetration of clean household energy in Kenya. An integrated approach is needed, encompassing training, behaviour change and communication, strengthening the supply chain for clean fuels, research and development, and incorporating clean household energy into existing health programmes (such as those for WASH, HIV/AIDS and school health).

↓ ***Table 6.*** *Barriers to uptake of clean household energy in Kenya*

Barriers	Proposed solutions
No cost–benefit analyses of use of clean and polluting fuels and their health effects Lack of equipment for measuring household pollution Inadequate knowledge and access to cleaner options, such as LPG Availability of biomass i. Behavioral (socio-cultural) barriers: • Consumers are largely unaware of the negative impacts associated with traditional cooking practices, and do not highly value health impacts of improved stoves. • Lack of investment in large-scale consumer marketing • Lifestyle change required to use clean stoves and fuels (cooking traditional recipes passed through generations, woodfuel is largely gathered for free, time is undervalued, perceptions around food tastes) ii. Economic / Market barriers: • High production costs make clean stoves more expensive compared to traditional stoves • Income variability of end-users and limited stove financing options • Limited market players and stove builders in the rural areas • A lack of coordination and integration across sectors iii. Technological development and transfer challenge: • Gaps in dissemination of available technical knowledge on clean cooking • Overemphasis on technology, under emphasis on the user-friendliness iv. Quality assurance limitations: • Data and knowledge deficit on adoption and the performance of improved stoves and clean fuels in real household conditions • Underdeveloped after-sales support (lack of spare parts and repairing services) • Many users are unable to tell the difference between a good quality clean stove and a sub-standard one.	Improve service delivery by the Ministry of Health to community level. Promote use of clean cooking stoves with cooking competitions, which could be extended to taste tests. Experienced partners should conduct behaviour change and communication campaigns. The existing reporting system, DHIS 2, should be used to collect data from tiers 1–5 (community to national referral hospitals) to ensure reporting of HAP-related illness. HAP should be included in curricula, with training by public health officers and technicians, and also in the curricula of public health officers, BSc degrees in environment, community health training centres and medical training colleges. The demand for public health officers should be facilitated, with networking among professionals in the sector. Innovation programmes should be scaled up. HAP programmes should be incorporated into social protection programmes such as cash transfers for the elderly, the school feeding programme and the Linda Mama initiative. The examples of other countries that have increased the supply of clean household fuels, such as Ethiopia and India, should be considered. Clean fuels should be introduced in institutions such as schools, hospitals, military camps, refugee camps and maternity shelters.

6.1 Barriers to adoption of clean household energy

Despite the benefits of clean household fuels for health, they are not yet widely adopted or used in Kenya. The barriers include poor communication, insufficient consumer awareness, little market development, price, regulatory and institutional barriers and poor quality products.

Communication: For other programmes that became accepted (malaria, HIV, WASH), international, regional and national communication was coordinated. A coordinated strategic plan and county-level action plans could help in the transition to clean household fuels, in alignment with the draft National Energy and Petroleum Policy 2015. A national communication strategy could provide common messages and a clearing-house for information on HAP. The strategy should provide information in appropriate formats and by suitable channels for policy-makers (summarizing technical studies on the benefits of clean household energy for national climate-resilient economic development goals for 2030), consumers (to overcome barriers to purchase, awareness of financial assistance), academia (to prioritize clean household energy for research funding to improve local evidence on its benefits, technology and market barriers) and entrepreneurs (market intelligence on improving the quality of products, consumer preferences). Influential personalities such as pop stars and television personalities could be used to promote clean household energy.

Consumer awareness: Television, radio and social media should be used to dispel myths about clean cooking fuels and change perceptions that LPG poses risks for burns and explosions. The widespread perception that food cooked on traditional fuels tastes better is a major barrier that should be addressed by taste tests and awareness-raising. Several small, periodic consumer education initiatives, such as Kenya Power's Pika na Pawa Show, Upishi Digi and Shamba Chef have been aired, but these are not sufficient to drive change at national level. Successful programmes in other sectors, such as Lighting Africa's Songa Mbele na Solar, demonstrate the importance of effective communication of benefits, where products can be purchased and ensuring adequate availability to meet the resulting demand.

Overall, Kenyans place the most value on educating themselves and their families, and the importance placed on putting food on the table increases with age (34). Health benefits are not yet a major factor in most Kenyan households' choice of fuels. Therefore, marketing of clean fuels should be based on consumer priorities, including saving money and time and durability. Technical standards are poorly understood by consumers and policy-makers, and WHO guidelines provide a useful benchmark only for technical audiences. Communication about clean fuels should be designed for different sectors. For example, the theft of solar lighting products is a concern for consumers who take out loans to purchase them. Such considerations should be included in the design of products to increase user acceptance.

Kenyans should be made aware that clean household energy is cheaper than other fuels. Insufficient information is disseminated about the relative costs of fuels. Although several analyses have shown that the cost of clean fuels is competitive with those of solid fuels and kerosene (35–37), there remains a widespread perception that clean fuels are too expensive. In many areas, especially urban and peri-urban areas, LPG is cheaper than charcoal for cooking, and electricity and solar energy are cheaper than kerosene for lighting. Better economic modelling and dissemination of economic comparisons to consumers and the Government should be priorities.

The Government has a well-established community health extension service, and community health workers should be given materials and messages to spread during visits and could distribute clean energy products. Health is not a priority for consumers when they choose a fuel and cooking technique, although some mothers have stopped using "dirty" fuels and moved to "safer" fuels after having children (26). Perceptions about

School children eating a meal
Credit: Nickson Otieno

the costs and benefits of clean cooking fuels are significantly influenced by women's groups and faith organizations. Coordination with these groups would ensure consistent messages and limit the propagation of myths.

Market development: The rapid increase in adoption of clean lighting fuels in Kenya has been due to a number of factors: innovative technology and financial mechanisms to meet consumers' needs; effective marketing and awareness-raising; functional, efficient supply chains; and public–private partnerships supported by Government policies. The market for clean cooking fuels, however, has lagged behind because of poor communication, limited investment, inadequate capacity, lack of appropriate incentives, poor-quality assurance mechanisms, lack of public–private partnerships and lack of Government policies. The high cost of supplying rural and peri-urban households, largely due to poor infrastructure and demographic characteristics, remains a barrier to development of a vibrant market for clean fuels. Competitive incentives are required, such as result-based financing, to compensate clean energy entrepreneurs for their initial investment, incremental costs and costs associated with extending operations.

Affordability: The high cost of LPG cylinders and of installing an electrical system is a major barrier to adoption of clean fuels. Lower-income consumers tend to find polluting fuels cheaper than clean fuels, as they cannot pay for LPG refills or lump-sum electricity bills. Charcoal and kerosene are bought regularly in small quantities in many informal urban settlements. Installments, smaller cylinders and pay-as-you-go options could change the perception of affordability. Rural residents often view the firewood they collect as free, although they undervalue the time they spend. Unattractive asset finance terms offered by micro-finance institutions (e.g. high interest on loans, long reimbursement) also discourage wider adoption of clean household energy. Cooking fuels tend to be a low priority among household investments.

Households that can afford only the smallest, 1-kg cylinder pay 37% more per kilogram than those that can afford the 13-kg cylinder; however, the large cylinders are often too expensive for low-income

households. Smaller cylinders improve access, despite the higher cost per unit presently charged for them (38). A number of low- and middle-income countries (India, Indonesia, Morocco, Peru, Senegal and Viet Nam) have found it is possible to achieve national transition to LPG among the poor (26, 38–41), and their experience could be used by Kenya in extending access to and use of LPG. Coordination with social welfare programmes may leverage resources and communication strategies to facilitate access by vulnerable and marginalized communities. UNICEF's pilot initiative "Energy for the Poor" in Kilifi and Garissa counties, which is distributing clean energy through social cash transfers, could be scaled up to increase access to clean fuels.

Regulatory and institutional barriers: Better coordination among ministries, between regional and national agencies, between the public and private sectors and among national and international agencies would improve implementation of clean household energy policies.

The barriers include counterproductive policies and strategies to encourage use of polluting fuels, such as promoting use of fast-maturing trees for fuel and licensing charcoal producers. They also propogate the view that "firewood is the only viable source of energy for local communities" and "Sustainable charcoal use has the potential to reduce Kenya's contribution to climate change compared with an alternative scenario of substituting wood fuel with fossil fuel" (42). The focus on the renewability of fuels as opposed to their health effects results in promotion of wood and charcoal and discouragement of the use of LPG because of its perceived negative effect on climate. The unsustainable use of trees for wood-fuel and charcoal production is a growing national environmental concern, and strategies for sustainable management of forest resources will result in increased availability of wood biomass from sustainable sources and efficient use of bio-energy.

Some blanket incentives such as broad subsidies for LPG favour consumers with high purchasing power instead of poor households. Despite the perception among stakeholders that the Government's "kerosene free" policy has increased kerosene prices, the Kenya Economic Survey (43) shows otherwise.

The National Environment Authority, which is the designated national authority for the Clean Development Mechanism, has an inadequate impact on the banking sector and on clean energy project managers and limited understanding of carbon trading.

Housing and settlements for large segments of the population are unplanned and unregulated, and planning regulations, and building codes are not enforced in informal settlements and rural settings. The current slum upgrading programme is addressing the quality of housing. "Green" building projects promote bioclimatic designs that ensure thermal comfort without space heating or cooling appliances and should be incorporated into housing programmes.

Poor transport infrastructure not only limits distribution of clean fuels but also increases pollution from dusty unpaved roads and vehicle emissions.

Quality: Assuring the quality of lighting and cooking household energy has been difficult. Imitation products and cheap imported alternatives have prevented increased market penetration because of bad publicity about the durability and performance of these products. Warranties on products would increase consumer confidence. With regard to solar products, there has been no attention to securing the systems from theft, so that financial models to encourage wider access are not used because consumers have to continue payments on stolen merchandise.

6.2 Opportunities for increasing access to clean fuels

6.2.1. Strategic partnerships with established collaborations

The work of various stakeholders should be better coordinated. Access to clean household energy is a cross-sectoral issue that requires interministerial partnerships and coordinated approaches. An evidence-based strategic plan for wide-scale introduction of clean energy should be coordinated by an interministerial technical steering group. International consensus on priorities, as was obtained for malaria, WASH and HIV initiatives, would indicate regional priorities.

Integration of clean household cooking fuels into large-scale electrification programmes is a priority, especially if it is coordinated with the programme for increasing access to LPG to meet the goal of sustainable energy for all by 2030. The model and experience of the Kenya Off-grid Solar Access Project (44) could be used to include the distribution of clean cooking fuels as part of electrification projects.

Clean household energy could be coordinated with the national "safety net" programme (45) to transition over 800 000 vulnerable households to clean energy for cooking and to reduce poverty and vulnerability in Kenya.

Maternal and child health, distribution of insecticide-treated nets, HIV and WASH programmes could include clean household energy to increase resilience to diseases. Providers of prenatal care could assess the household energy practices of mothers and advise them on the health benefits of clean energy. Coordination with the Ministry of Education could ensure that educational institutions that provide cooked meals use clean energy to limit emissions near children, introduce local women cooks to clean fuels and raise awareness in local communities. Innovative ways of integrating clean household energy into educational institutions might include organizing annual "clean energy awareness day", clean school kitchen projects, clean energy trophies in school sports and drama competitions and raising awareness of clean energy at annual meetings of parents associations.

Access to clean energy is recognized as essential to a low-carbon climate-resilient development pathway. In the National Climate Change Action Plan 2013–2017 (46), it is estimated that the mitigation potential of increasing distributed clean energy technologies will be > 10 Mt of CO2 equivalent per year in 2030. Better coordination with national climate change initiatives would significantly contribute to the transition to clean household energy. The Government could ensure more active involvement of the Ministry of the Environment in interministerial health, energy and environment coordination mechanisms, such as the Technical Working Group on Climate Change, Health and Energy and the proposed Health and Environment Framework. Access to clean household energy should be part of Kenya's nationally determined contribution to the United Nations Framework Convention on Climate Change. Carbon finance could provide additional funding for access to clean energy. Clean household energy could be integrated into environmental education programmes, and local evidence could be generated on synergies and trade-offs between climate change mitigation, energy access and broader development goals.

6.2.2. Interventions to increase access

Interventions would be based on accessibility, household income and the strength of the local infrastructure. In counties in which charcoal and kerosene are widely used, distribution networks could be improved to increase access to LPG. Urban areas with filling plants could be prioritized

Demonstrating the use of solar cookers to a women's group
Credit: Nickson Otieno

for full access. Initial large-scale interventions to increase access to LPG should be conducted in Nairobi, Mombasa, Kajiado, Kisumu, Nakuru and Kiambu counties. Grid-based electricity would be the main lighting fuel and solar devices secondary sources. Market-based approaches should be available, with flexible payment possibilities. Consumer awareness should be raised by labelling clean household energy as convenient, aspirational and economical in the long run, through the mass media.

In rural towns, electricity for lighting and other power needs would be met by large-scale grid electrification and off-grid mini-grids, with solar lamps for secondary lighting. LPG should be promoted as the main cooking fuel according to the possibility of setting up distribution hubs. Consumer awareness could be raised by emphasizing the rising cost of firewood and charcoal. In villages and dispersed rural areas, solar home systems would be the main source of household lighting. Mini-grids around communal facilities such as schools and markets would provide electricity, and improved combustion stoves with chimneys, biogas and bioethanol would be used for cooking. Financing approaches could include subsidized distribution through nongovernmental and Government social welfare programmes, social group financing and pay-as-you-go for direct market purchases. Clean household energy should be promoted e.g. during the rainy season, when the wood supply is unreliable, and at harvest time, when household income peaks. Growing concern about the diminishing supplies of firewood and charcoal and a perception that wood is "the poor man's fuel" should create an aspiration for modern fuels. Local opinion leaders, social media and television should be used to dispel perceptions about food taste and traditional cooking methods and to present clean household energy as a right, empowerment for women and a source of livelihoods for young people and women.

The Government should focus on the receiving end of technology transfer, creating the best conditions for long-term uptake of the new technologies by tailoring them to local needs, engaging local workers and business partners and building technical and market development capacity.

6.2.3. A national HAP programme

An evidence-based action plan to increase uptake of clean household energy and reduce HAP should include market development, finance, coordination of initiatives and timetables appropriate to each county. The Ministry of Health would be responsible for overall coordination of the plan, implemented jointly with the Ministry of Energy and Petroleum and the Ministry of the Environment and Natural Resources. The latter would be responsible for managing carbon financing and the Ministry of Energy and Petroleum for overseeing technical assistance and capacity-building on energy technologies and fuels, including for investment. A clean household energy programme coordination unit would be set up in the Ministry of Health, which, with the co-implementing line ministries, would define the programme areas according to technical and policy priorities, resolve problems that require high-level intervention, monitor implementation, consolidate information on progress and evaluate the programme.

The Government should support the technical working group on climate change, energy and health in preparing the national action plan, identifying roles and responsibilities. The group would find a mechanism to strengthen and build synergy among intersectoral technical committees and working groups, and the SE4All secretariat would include a unit mandated to coordinate health and energy initiatives. The Government should also improve coordination between county governments and the national Government's energy centres and establish a "county clean air" unit at the Council of Governors. In counties, technical committees on HAP could be set up for intersectoral coordination of HAP programmes. County governments should use existing mechanisms for community input, to avoid duplication. The channels of communication and support networks of women's and youth groups could be strengthened.

6.2.4. Financial mechanisms to make clean energy affordable

The Government is advised to play a central role in encouraging the private sector, including coherent, consistent strategies, policies, incentives and funding schemes to facilitate investment and help new businesses to begin. This will entail political commitment to universal access to clean household energy that involves appropriate institutions and incentive schemes for participation and ownership; a clear funding strategy based on various sources, including international funds, subsidies from national utilities and social welfare to vulnerable households; a strong public–private partnership to offset the high cost of distribution of clean energy technologies and fuels; and pilot programmes to collect technical, social and economic data on the preferences and needs of end-users, including their willingness to accept new technologies and fuels.

Financial mechanisms to catalyse the uptake of clean fuels should be based on the concentration of the working population in urban areas and of their dependents in rural areas. Thus, market-based interventions might be targeted to urban areas and subsidized or nongovernmental organization interventions to rural areas. Cross-subsidies could offset the costs of transport and distribution in poor rural communities in remote areas. Consumers prefer payment in installments and paying for clean fuels by saving with an informal group and arrangements with a vendor. Financial mechanisms for acquisition of clean household energy may include:

- formal financial models, either funding microfinance institutions to offer interest-free loans or funding manufacturers and distributors to assume risks;
- encouraging consumer borrowing for purchase of clean energy products by marketing them as an investment to meet goals such as guaranteeing the quality of their children's education;
- optimizing climate finance to fund subsidized clean household energy projects;
- raising grants and corporate funding through coordinated corporate social responsibility for distribution of clean cooking fuels to poor consumers;

- supplementing the "safety net" programme by extending it to peri-urban and urban households; and
- cross-subsidization to support transition of poor populations to clean energy.

The established market approaches and distribution channels for solar home systems could be used to distribute clean cooking stoves, as an additional product and an aspirational acquisition. Long-term market and infrastructure development through public–private partnerships has worked well in Kenya's solar energy sector, catalysed by large investments by international organizations matched by Government contributions and an enabling policy and regulatory environment.

Building a vibrant market requires studies of possible purchasers and the role of women both as consumers and as potential distributors of solar lights; services to help companies entering the market to develop their business models, sales and marketing strategies and product distribution networks; financing instruments such as results-based finance and debt financing to meet the initial, incremental and operational costs of extension to unserved markets; and training technicians to provide after-sales maintenance.

The cash savings from use of clean fuels could be used to justify introducing them into institutional kitchens. A market for clean institutional stoves could be built on the basis of pilot projects in educational and custodial institutions, through partnerships with hotel and restaurant business associations and kitchen remodelling in hospitals and other health care facilities.

Government policy to encourage investment could include feed-in tariffs for electricity generated from renewable energy sources, which would require the Kenya Power and Lighting Company to enter into power purchasing agreements with independent power producers for 20 years and to guarantee priority purchase. The Government could also exempt solar products from value-added tax, to further reduce the cost to consumers. The support of donors and international organizations will be crucial.

6.2.5. Capacity-building

The Government should support activities to strengthen the capacity of stakeholders. The Ministry of Energy and Petroleum should support energy centres in organizing demonstrations for consumers and subsidized training to entrepreneurs on clean energy technologies. The Ministry of Health could establish a strategic planning and programme management unit for coordination with other ministries, provide technical assistance and undertake sector studies, policy evaluation, monitoring and evaluation. County governments could include access to clean household energy in their development plans, conduct studies to guide activities, hire new staff and train all staff in clean household energy; and build the capacity of ward administrators to convene community discussions on energy issues.

Research institutions should be provided with up-to-date equipment for monitoring air quality. Funding should be prioritized for research on topics that form the basis of policy and reduce the health burden. Multidisciplinary research should be conducted to obtain empirical evidence on the advantages of clean cooking. The capacity of the National Bureau of Statistics and the Institute for Public Policy Research and Analysis should be strengthened to provide relevant statistics and policy research. A plan for research on clean household energy would guide multidisciplinary, coordinated work that could be used by Government and other research institutions.

Education of consumers should increase their understanding of the operation of safe off-grid lighting products, where they can be found and their cost and benefits. Extensive consumer education campaigns have been conducted, with road shows, product discussion forums and radio campaigns to build consumer awareness. The common message is the advantage of quality-assured clean lighting products over polluting kerosene lamps. The mass media have been used by including mention of quality-assured solar products in television programmes and radio talk shows and by a Christmas campaign of print and television messages about solar lighting products targeted to urban and peri-urban consumers.

6.2.6. Strengthening the evidence base to influence policy

The Government could evaluate the impact of household energy policies on health outcomes and justify their investment from the point of view of the treatment costs and productivity avoided. Policy-makers should understand the importance of promoting clean fuels rather than intermediate measures (e.g. improved stoves) by demonstrations of the impact on reducing the burden of disease. HAP is not well covered by research funding in Kenya. To increase prioritization and improve the quality of coordinated research and innovation for clean household energy, coordination should be pursued with the National Innovation Agency, the National Research Fund and the National Commission for Science and Technology. Programmes should be set up to fund faculty research into clean household energy and support post-doctorate fellowships in policy think-tanks.

More local measurements and data are required to improve the quality of the evidence on the benefits of clean household energy options. Evidence of the associated economic losses would broaden "ownership" of energy access issues to include, for example, the ministries of both finance and health. Data on health and living conditions are collected regularly, but they could be extended to provide a basis for evaluating policies. Empirical evidence is needed on the potential of clean household energy to reduce maternal disease and child deaths. Evidence should be provided that universal access to clean household energy creates employment opportunities and that jobs may be lost if clean fuels are not promoted.

Energy should be linked to the political goals of social development, social inclusion and social protection, with evidence that access to clean household energy reduces violence against women and improves children's education. Evidence should be provided on the costs avoided by reducing the environmental impact of "dirty" household energy, from the trees saved to the costs of sustained land degradation and reforestation. Data on access to electricity should be improved, as current statistics apply only to actual connections (i.e. meters) and not households, the population served or consumption by household task.

A woman carrying a bunch of wood in her village.
Credit: Nick Fox / shutterstock

7 Conclusions

The health sector could encourage adoption and sustained use of clean fuels and technologies for household energy in four areas.

7.1 Convening and coordination

Support should be provided for existing interministerial groups, such as the Technical Working Group on Climate Change, Health and Energy, and the proposed Health and Environment Framework. A committee could be established to discuss and find solutions to household air pollution. Current policies should be reviewed and recommendations made to ensure that the health effects of household air pollution are given priority.

7.2 Assessment, monitoring and evaluation

A monitoring and evaluation programme could be set up to determine all uses of household energy, the types of energy used and the resulting household air pollution. Household energy policy scenarios could be modelled, and their health impact assessed. Capacity for monitoring and evaluation in the country should be built by training and by partnerships with international and national organizations.

7.3 Communication and education

Training in the health effects of household air pollution should be provided in the health and other sectors. For the general public, existing household energy communication programmes, such as cooking shows, could be used to communicate messages about clean household energy technologies and to promote awareness of those that are cheaper than traditional fuels. The public should be made aware of the contribution of household air pollution to ambient air pollution and of the important effects on health.

7.4 Policy advocacy

The Government could promote a "health-in-all policies" approach and adoption of WHO standards. Policies for programmes to introduce clean household energy should be encouraged, such as tax incentives for the use of LPG and solar energy.

8

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Annex 1. Stakeholder organizations

Government agencies

Ministry of Energy and Petroleum

The Ministry's programmes relevant to increasing use of clean household energy are listed in Table A1.1.

↓ ***Table A1.1.*** *Policies and programmes related to household energy*

Programme or project	Objectives and outcomes
Kenya Off-grid Solar Access Project	Jointly initiated by the Government and the World Bank in September 2017 to provide electricity services to approximately 277 000 households (nearly 1.3 million people), 1097 community facilities and 380 boreholes in 14 marginalized counties; 150 000 efficient cookstoves will be sold and installed.
Last Mile Project	The aim is to ensure affordable electricity connections to households to achieve over 70% connectivity by 2017 and universal access by 2020 .The potential customers will be connected at a one-off cost of 15 000 KES or payment in installments in their monthly bills for 36 months.
LPG uptake promotion	The aim is to increase penetration of LPG in low-income households, with construction of mini-LPG cylinder storage and refilling plants across the country. The Ministry is procuring 1.2 million empty domestic 6-kg LPG cylinders fitted with unified valves, burners and grills, to be distributed to low-income households.
LPG storage and bottling facilities	Construction of LPG storage and filling facilities in Nairobi initially and in Eldoret, Nakuru, Kisumu and Sagana later to ensure LPG at affordable prices.
Energy standards	The Minimum Energy Performance Standards Regulations 2015, developed in collaboration with the Kenya Bureau of Standards, should improve the energy efficiency of household and industrial appliances. The standards are applicable to six products, including fluorescent lamps, ballasts and compact fluorescent lamps.

Programme or project	Objectives and outcomes
Energy centres	Demonstration of renewable energy technologies (efficient wood-burning stoves, biogas, solar photovoltaic panels and wind turbines) at 15 energy centres.
Laws, policies and strategies	• Sessional Paper No. 4 of 2004 • Energy Act 2006 • Designation of Energy Users Gazettement • The Draft Energy (Improved Biomass Cookstoves) Regulations • The Energy (Solar Photovoltaic Systems) Regulations, 2012 • The Energy (Energy Management) Regulations, 2012 • The Energy (Solar Water Heating) Regulations, 2012. • Regulatory Impact Statement – Draft Energy (Appliances Energy Performance) • Draft Appliances Energy Performance Regulations • Kerosene-free Kenya • Sustainable Energy for All (SE4All) action agenda

Ministry of Environment and Natural Resources

Policies:

- Air Quality Regulations: mainly for ambient air pollution from static and mobile sources;
- Forest Act, The Forest (Charcoal) Rules, 2009;
- Waste and Wastewater Regulations: applicable to biogas energy;
- Climate Change Act (2016);
- Kenya National Adaptation Plan 2015–2030: energy and health are two of the eight priority areas for adaptation. Access to reliable, affordable energy is identified as a key component of building resilience to climate change.
- National Climate Change Action Plan: energy is identified as essential for socioeconomic development, and distributed clean energy for households and institutions (such as solar lanterns, improved cookstoves, LPG cookstoves and energy-efficient lighting and appliances), renewable energy and off-grid electricity generation systems for a low-carbon climate-resilient pathway.
- The Green Economy Strategy and Implementation Plan 2016–2030 commit the Government to increase the share of renewable energy on the national grid to at least 70%; review the Feed-in-Tariff policy to include more off-grid generation and net metering; and promote use of bio-energy in households, public institutions and commercial enterprises.

Programmes:

- The Low-emission, Climate-resilient Development project funded through UNDP supports development of minimum energy performance standards for electrical appliances, a technical and socioeconomic survey of solar lighting kits, establishment of clean energy business information centres and training of trainers on solar water heating design, installation and maintenance.
- The Forest for Energy cluster of the National Forest Programme 2016–2030 calls for improved access to energy by increased use of biomass and efficient technology.
- The National Environment Authority is the designated national authority for receiving funds to combat climate change, including carbon finance for local clean energy projects.

- The National Environment Trust Fund supports clean household energy enterprises through "green innovation awards".

Ministry of Transport, Infrastructure, Housing and Urban Development

- Physical Planning Act, Revised Edition 2012
- The Building Code
- National Building Regulations 2014

Other relevant ministries

Ministry of Trade and Industrialization

- Minimum energy performance standards (Kenya Bureau of Standards)
- Research, development and testing of energy technologies (Kenya Industrial Research Development Institute)

Ministry of Agriculture

- Integration of clean energy access into the agricultural extension workers package
- Promotion of biogas with livestock programmes
- Encouragement of alternative uses of agricultural wastes, e.g. as organic fertilizers to reduce open-field burning and use of agricultural residues as cooking fuel

Other stakeholders

Category of stakeholder	Organization
Government	Ministries of Energy; Environment and Forestry; Agriculture and Health Kenya Bureau of Standards (KEBS), Kenya Industrial Research Development Institute (KIRDI), Kenya Forestry Research Institute (KEFRI).
International organizations	• World Bank, International Finance Corporation (IFC); • World Health Organization (WHO); • United Nations Development Programme (UNDP); • United Nations Children's Fund (UNICEF); • United Nations Human Settlements Programme (UN-Habitat); • United Nations Industrial Development Organization (UNIDO); • United Nations High Commissioner for Refugees (UNHCR).
Selected bilateral corporations	• United States Centers for Disease Control and Prevention (CDC); • UK Department for International Development (DFID); • Danish International Development Agency (DANIDA); • Norwegian Agency for Development Corporation (NORAD); • Swedish International Development Corporation Agency (SIDA); • United States Agency for International Development (USAID).

Category of stakeholder	Organization
Selected nongovernmental and community-based organizations and projects	• Humanist Institute for Cooperation (HIVOS) • German Corporation for International Cooperation (GIZ) • Netherlands Development Organisation (SNV) • World Wide Fund for Nature (WWF) • Global Alliance for Clean Cookstoves (GACC) • Practical Action • CARE International • Population Services Kenya • Energy 4 Impact • E4Impact Foundation • Sustainable Community Development Services (SCODE) • Solar Cookers International (SCI) • Natural Resources and Waste Management Alliance (NAREWAMA) • Wildlife Works • CO2Balance • Community Action on Environment and Development (CAED) • Kenya Energy and Environment Organization (KENGO) • Keyo Pottery Women's Group • Kayole Environmental Management Association • Green Africa Foundation • Micro Enterprise Support Programme Trust (MESPT)
Green innovation prizes and programmes	• National Environment Trust Fund (NETFUND) • Kenya Climate Innovation Centre (KCIC)
Professional associations and lobby groups	• Clean Cookstove Association of Kenya (CCAK) • Improved Stoves Association of Kenya (ISAK) • Kenya Biogas Association • Petroleum Institute of East Africa (PIEA) • Kenya Association of Manufacturers (KAM)
Training and research	• Universities and TVETs • Stockholm Environment Institute (SEI) • African Centre for Technology Studies (ACTS) • World Agroforestry Centre (ICRAF)
Enterprises	Biolite East Africa, Koko Networks, BURN, Leocome Ltd, Megagas, ClimateCare, NIKO GREEN Ltd, Tindah Ecofuels, Eco-Charcoal Ltd, Consumer Choice Ltd, IKO Briq Ltd, Cookswell, Acacia Innovations, Ecozoom, Envirofit Kenya, Livelyhood/Ismart Kenya, Pamoja Life, Powerspot, WEET Enterprises, Bentos Energy, Kenya Power, etc.

International initiatives to increase access to clean energy

Lighting Africa (International Finance Corporation and World Bank)

The flagship Lighting Africa programme for Kenya was initiated in 2009, when the off-grid market was beginning. Consumer awareness was low, and solar lantern use was only about 2%. The programme activities resulted in a vibrant private sector, and over 1500 small and medium-sized enterprises SMEs currently sell solar lanterns. The uptake of solar lighting increased fourfold to about 8% in 2013, the market growing by over 200%. Families living off-grid in rural Kenya bought over 700 000 solar lanterns (1).

Kenya National Biogas Project

The Kenya National Domestic Biogas Programme was launched as a component of the Africa Biogas Partnership Programme, supported by the Dutch Government through the Humanist Institute for Cooperation with Developing Countries as the fund manager and the Netherlands Development Organisation as technical advisor. The national stakeholder-appointed implementing agency is the Kenya National Federation of Agricultural Producers. A public–private partnership model was used to promote, incentivize and install 35 500 000 domestic biogas plants in Kenya between July 2009 and 2017. Since 2009, over 14 000 biogas plants of the traditional brick-laid design have been installed. In the second phase of the programme, between 2014 and 2017, the target was to install 27 500 digesters of both traditional and innovative design (2).

Clean Cooking for Africa programme

The Clean Cooking for Africa Programme of the KfW Development Bank, is funded through the European Union–Africa Infrastructure Fund and implemented by the Global LPG Partnership to support certain African countries in developing the policies and investments required for extending effective, safe, sustainable markets for LPG cooking fuel. In Kenya:

- an LPG market assessment and feasibility study has been completed;
- an initial US$ 341 million investments identified for value-chain (supply and demand side);
- the Government and the National Oil Company of Kenya have set a goal to switch 45% of the population to LPG in three years (2017–2019);
- the Global LPG Partnership and the World Bank are designing terms of reference for joint LPG projects; and
- the development and enforcement of a new LPG policy, law and regulations is being supported (3).

Energising Development

Energising Development is an energy access partnership financed by Germany, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom. It promotes sustainable access to modern energy services that are long-lasting, affordable and appreciated by users to meet the needs of the poor. Since 2005, the partnership has been promoting access to sustainable energy for all. GIZ cooperates with the Netherlands Enterprise Agency in the global programme (4).

Energy and Environment Partnership

The Energy and Environment Partnership promotes renewable energy, energy efficiency and investments in clean technology. The programme in southern and East Africa is funded jointly by the Ministry of Foreign Affairs of Finland (lead donor), the Austrian Development Agency and the Department for International Development in the United Kingdom. The programme began in March 2010, providing grants to a number of companies to establish and scale up renewable energy businesses and projects (5). It also supports research into the briquette market in East Africa.

Capital Access for Renewable Energy Enterprises project

Global Village Energy Partnership International, with the support of the Swedish International Development Cooperation Agency, is improving access to capital for the renewable energy markets in four countries in East Africa. In Kenya, the project will support medium and small businesses to produce improved cookstoves and briquettes. It seeks to increase the quality and uptake of locally made domestic biomass stoves and biomass briquettes by improving product design, marketing and distribution and scaling up production for potential local producers. About 20 producers of improved cookstoves,

20 suppliers of ceramic liners, 20 producers of biomass briquettes and a network of about 130 retailers are supported by the project.

Scaling-up Renewable Energy programme in low-income countries

The programme is funded by the Strategic Climate Fund, one of two climate investment funds, and is implemented by the African Development Bank. Kenya is one of six pilot countries. The programme supports Kenya's initiatives to scale up renewable energy solutions and expand markets for renewable energy (6).

Power Africa

In Kenya, Power Africa, financed by the US Agency for International Development, is supporting development of the energy sector through grants, technical assistance and investment promotion (7). Some of its projects are:

- mobilizing more than US$ 1 billion in private investment to accelerate geothermal and wind projects for electricity;
- a grid management support programme to provide technical assistance to address challenges in integrating intermittent renewable energy into the national grid; and
- using innovative solutions to connect rural Kenyans to the electricity grid and supporting small on-grid power generation projects and projects to provide off-grid and mini-grid solutions for small communities.

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Annex 2. Ministry of Health vaccination and nutrition programmes

Vaccination and nutrition programmes are important components of strategies to reduce the health effects of use of solid fuels, as they decrease the underlying levels of diseases that are associated with exposure to household air pollution. They also provide opportunities for introducing information about and access to clean fuels in communities.

Pneumococcal vaccination

Both pneumococcal vaccine (PCV) 10 and PCV13 are licensed for vaccination of infants and children from 6 weeks to 5 years of age against invasive disease, pneumonia and acute otitis media caused by the respective vaccine serotypes of S. pneumoniae. In addition, PCV13 is licensed for use in the prevention of pneumococcal disease in adults aged > 50 years. For PCV vaccination of infants, WHO recommends three primary doses at 6, 10 and 14 weeks or 2, 4 and 6 months or two primary doses plus a booster given between 9 and 15 months of age. The safety and reactogenicity of pneumococcal conjugate vaccines are well established, and compatibility with major childhood vaccines has been demonstrated. PCV10 was introduced into the routine immunization schedule in Kenya in 2011 for vaccination of children at 6, 10 and 14 weeks. Table A2.1 shows the immunization schedule in Kenya

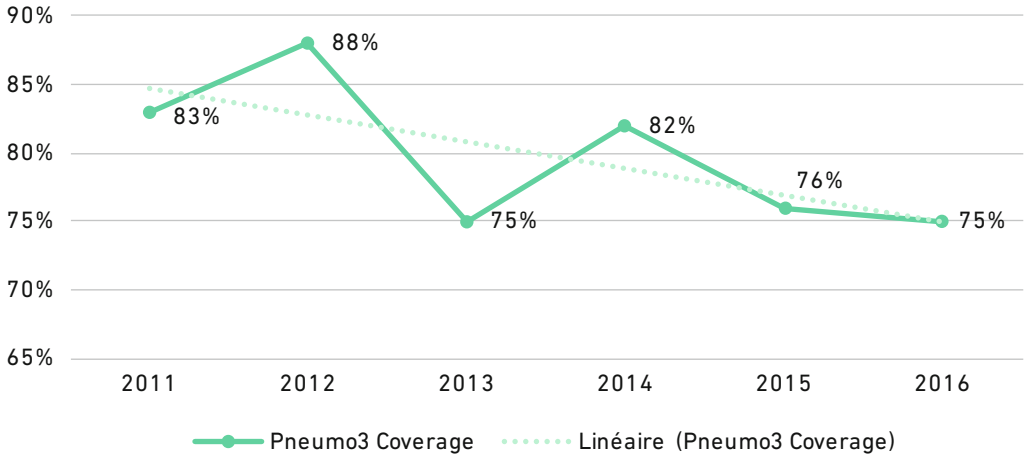
↓ ***Table A2.1.*** *Immunization schedule in Kenya*

Age	Antigen	Disease prevented
Birth	BCG, OPV and Hep B	Tuberculosis, poliomyelitis and hepatitis B
6 weeks	DPT, HIB, Hep B, OPV, pneumococcal, rotavirus	Diphtheria, pertussis, tetanus, Haemophilus influenzae type B influenza, hepatitis B, poliomyelitis, pneumonia and rotavirus diarrhoeal disease
10 weeks	DPT, HIB, Hep B, OPV, pneumococcal, rotavirus	Diphtheria, pertussis, tetanus, Haemophilus influenzae type B influenza, hepatitis B, poliomyelitis, pneumonia and rotavirus diarrhoeal disease

14 weeks	DPT, HIB, Hep B, OPV, pneumococcal, rotavirus	Diphtheria, pertussis, tetanus, Haemophilus influenzae type B influenza, hepatitis B, poliomyelitis, pneumonia and rotavirus diarrhoeal disease
6 months	Vitamin A	Vitamin A deficiency
9 months	Measles and yellow fever	Measles and yellow fever

Source: reference 1.

After the introduction of PCV10 in 2011, considerable coverage was achieved initially but dropped significantly in 2013, 2015 and 2016 (Fig. A2.1), with a steady decline in coverage. In 2017, the Kenya Expanded Programme on Immunization targeted 1 560 953 children for vaccination. Between January and September, 828 242 children (71%) received the first dose, 771 876 (66%) received the second, and 746 727 (64%) received the third dose.



↑ ***Fig. A2.1.*** *Percentage coverage with three doses of pneumococcal vaccine 10, Kenya, 2011-2016*

Source: reference 1.

Some of the barriers to achieving universal pneumococcal vaccination are:

- low awareness that demand can be created by advocacy and social mobilization in order to reach all children;
- inadequate supplies of vaccines, syringes and cold chain equipment;
- lack of capacity-building and mentorship on vaccination for health workers in maternal and child health clinics;
- poor documentation of immunization activities; and
- inadequate record-keeping at health facilities.

Nutrition programmes

Nutrition programmes in Kenya are headed by the Nutrition and Dietetics unit within the division of Preventive and Promotive Health. Some current nutrition projects are described below.

Kenya Nutrition and Health Program Plus

A 5-year project of maternal, newborn and child health activities is being implemented in five

counties (Busia, Tharaka Nithi, Kitui, Marsabit and Samburu). The aim is to end preventable child and maternal deaths by improving food and nutrition security by increasing access to and demand for good-quality interventions in the community and at facilities and strengthening nutrition commodity management. The project is funded by the US Agency for International Development under a "cost-plus fixed-fee completion" contract and an "indefinite delivery/indefinite quantity" contract from 1 January 2015 to 31 December 2019 (2).

International Medical Corps

The International Medical Corps, with funding from the US Office of Foreign Disaster Assistance and UNICEF, is providing nutrition aid in four counties of Kenya where severe drought and instability due to ethnic conflicts has contributed to increasing vulnerability and malnutrition among children < 5 years and pregnant and lactating women. The International Medical Corps builds the capacity of health care providers to deliver 11 high-impact interventions.

Kenya Red Cross Society

This organization focuses on reducing the risk of disaster by increasing food security. The aim of the projects is to diversify livelihoods in crop production by educating farmers in use of both conventional and climate-adapted farming methods (i.e. greenhouses). They are being conducted in Turkana, East Pokot, Siaya, Kajiado, Tana River, Garissa, Mwingi, Kilifi, Wajir, Marsabit and Mandera counties. Nutrition education is integrated in the projects to improve household access to diversified diets (3).

References

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3. Nutrition and Dietetics unit, Ministry of Health (http://www.nutritionhealth.or.ke/).

Total Meko LPG stove and cylinder
Credit: Nigel Bruce

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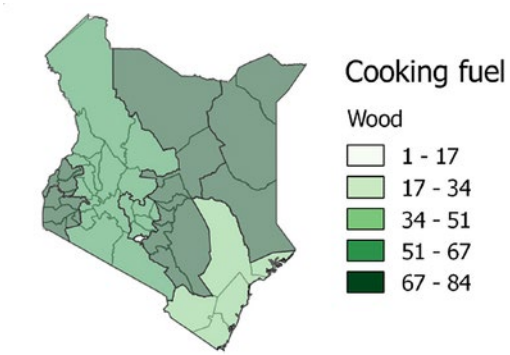
Annex 3. Current household fuel use

Firewood



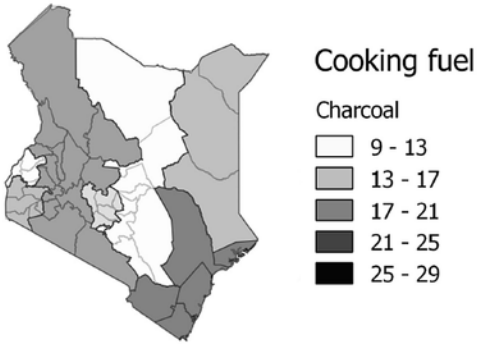
Biomass fuels are the largest source of primary energy in Kenya, wood-fuel (firewood and charcoal) accounting for about 69% of the total consumption. About 55% of it is derived from farmland in the form of woody biomass, crop residue and animal waste and the remaining 45% from forests (1). The users are characterized in Table A3.1.

↓ ***Table A3.1.*** *Market segmentation of primary wood fuel users*

Group	Characteristics	Challenges
Wood collectors: 21.6 milion, 55% of households	Predominantly lower-income, 99% rural, 1% urban	Lack of disposable income to buy other energy sources Time-consuming collection, scarcity Lack of awareness of harm to health
Low-income purchasers: 2.7 million, 7% of households	Income < 10 000 KES/month, 89% rural, 11% urban	High fuel expenditure relative to income Lack of awareness of harm to health Modern energy considered to be unaffordable or inaccessible
Mid–high-income purchasers: 2.9 million, 7% of households	Medium–high income (> 10 000 KES/month, 90% rural, 10% urban	Lack of awareness of harm but more sensitive to time required to gather fuel and cook Modern energy considered to be inaccessible

Source: Adapted from reference 2

Charcoal



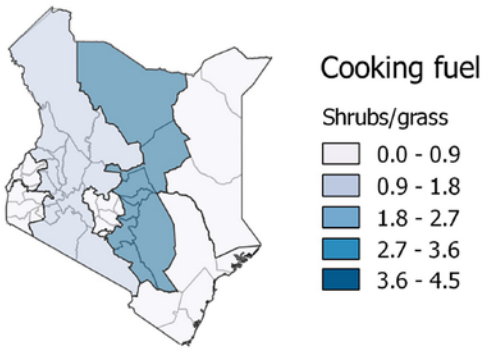
Charcoal is used by all socioeconomic groups in Kenya. High-income households use it on special occasions for cooking in large pots. Use is higher in urban households, mainly due to its ready availability and affordability in comparison with options such as LPG and kerosene. The users are characterized in Table A3.2.

↓ ***Table A3.2.*** *Market segmentation of charcoal fuel users*

Size of group	Characteristics	Challenges
Rural users: 2.6 million, 7% of households	11% low income, 73% middle income, 16% high income	Those with lower incomes still rely mainly on firewood (gathered or purchased)
Urban users: 4.1 million, 11% of households	4% low income, 53% middle income, 43% high income	High premiums paid by low-income users (especially in slums), and fuel represents a very large proportion of income Large proportion of income for mid-income urban buyers but financially difficult to change energy source

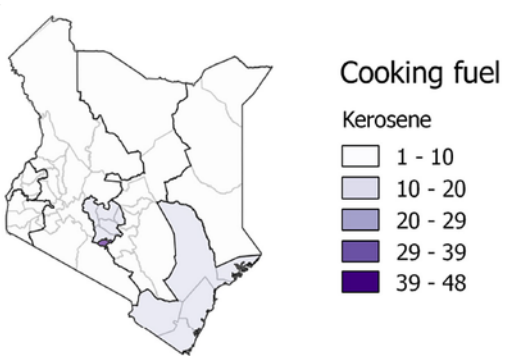
Source: reference 3

Dung and crop residues



Dung is used in remote rural pastoral villages for lighting and heating. Dung is made into briquette in some small-scale projects.

Sawdust, maize cobs and fibres are used mainly in rural areas, depending on availability and season.



Kerosene

Kerosene is the preferred fuel in urban and peri-urban households, mainly for speed of cooking (Table A3.3).

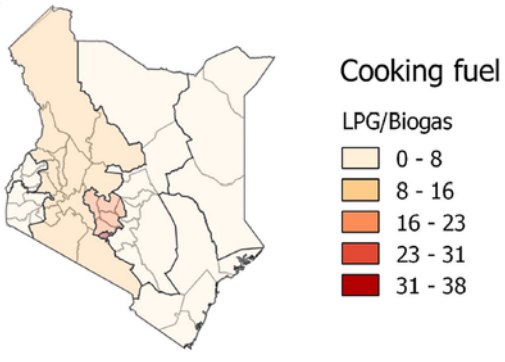
↓ ***Table A3.3.*** *Use of kerosene*

Household location	Percentage using kerosene	Use (%)			
		Starting a wood stove	Starting a charcoal stove	Lighting lamps	Cooking
Urban	72.7	21.4	19.6	87.5	53.6
Rural	96.7	4.9	2.4	95.8	8.1

Source: reference 4

As household use of kerosene is associated with high levels of pollutants and the risk of fire (5), Kenya's new Energy Bill sets a target of eliminating kerosene use in households by 2022.

LPG



The current market for LPG in Kenya is underdeveloped, as only 5–7% of households use it as the primary cooking fuel. Of the 2.2 million users, 88% are urban and 12% rural, and 1% are low-income, 34% middle-income and 65% high-income households. The barriers to uptake are low availability of LPG in rural areas and the high initial cost of cylinders.

Legislation and standards to regulate the LPG industry have been prepared by various ministries and agencies, with common enforcement capacity. Ministry of Energy documents and its website, the website and regulations of the Energy Regulatory Commission and Dalberg Global Development Advisers (6) provide the following information. The Finance Bill (2005), in accordance with East African Community regulations, allows importation of LPG through Mombasa and a 15% surcharge on imports through neighbouring countries. Gas importers pay 0.475% for inspection of imported gas. The Energy Act (2006) authorized the Energy Regulatory Commission to regulate imports, exports, transport, refining, storage and sales of petroleum and petroleum products; issue, renew, modify, suspend or revoke licenses and permits; formulate, enforce and review environmental, health and safety standards; and an energy tribunal to arbitrate disputes between stakeholders in the energy sector. The Energy (LGP) Regulations (2009) are designed to increase consumer access by effective regulation of LPG import, export, transport, refining, storage and sale. Initiatives to increase competition include establishing an LPG cylinder exchange pool and standardizing the valve on LPG cylinders. The Regulations include measures to protect public safety by ensuring quality.

Periodic standards include KS 03-91 on specification for LPG; KS ISO 4706 on refillable welded steel cylinders and test pressure; KS 06-896 on specification for periodic inspection, testing and maintenance of transportable gas containers; KS 201:2007 on unified valves for LPG; and KS 1938 Parts 1–3 on handling, storage and distribution of LPG in domestic, commercial and industrial installations.

The Ministry of Trade Weights and Measures Department audits LPG dispensing procedures and equipment to ensure consumer safety. The National Environmental Management Authority and the Department of Occupational Safety and Health assess the potential impacts of LPG filling depots. The Bureau of Standards issues technical standards for cylinder design, construction, transport and maintenance and a code of practice for operation. The Cylinder Exchange Pool Committee, which regulates the exchange of cylinders to promote competition, comprises one representative from the Ministry of Energy and Petroleum, one from the Bureau of Standards and six from marketing companies. Participation in the Pool is mandatory for all fillers and wholesalers.

The Energy Tribunal is a quasi-judicial body that mediates disputes between marketing companies and appeals against decisions of the Energy Regulatory Commission. It implements the Energy (LPG) Regulations, reviews and licenses LPG operations (import, storage, transport, filling, retail), is responsible for ensuring consumer safety and is responsible for enforcing laws on illegal refilling and cross-filling, with police support if necessary.

Household uses

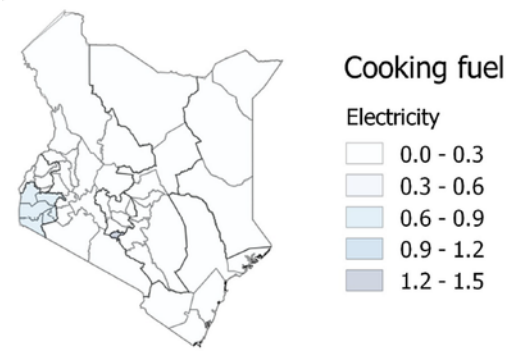
LPG is considered the most convenient, prestigious fuel, but its use is limited by its price. Thus, it is used by 2% of households with a monthly income < 10 000 KES, 23% of those earning 10 000–20 000 KES, 32% of those earning 20 000–30 000 KES, 20% of those earning 30 000–40 000 KES, 50% of those earning 40 000–50 000 KES and 97% of those with a monthly income > 50 000 KES (3).

Market and supply constraints

The main constraints to adoption and penetration of LPG in Kenya are cost, supply and enforcement of regulations. The initial deposit for a cylinder and the cost of stoves limit its affordability for consumers, and the high cost of bulk storage in Mombasa discourages suppliers, although this will fall with increased capacity and price competition. Nevertheless, unusually high margins for importers, marketers and distributors constitute up to 90% of the final retail cost for consumers. Another factor is the fluctuating price of petroleum products. Limited bulk storage capacity and filling stations outside Nairobi and Mombasa result in a sporadic supply and costs for transport. Uneven retail distribution also discourages access and reduces the incentive to adopt LPG. Illegal re-filling and cross-filling of cylinders and theft and re-branding of cylinders result in lost revenue for distributors and fewer points for safety checks for consumers. Weak enforcement of obligations, such as non-payment or collection of cylinders, is also a problem.

There is inadequate inland infrastructure for cylinder filling, storage and distribution, which limit access outside the core markets of Nairobi and Mombasa, and access in rural areas is extremely low. Because of weaknesses in supply and importing capability, shortages have been common in recent years.

Electricity



Electrification has hitherto favoured institutional consumers. Table A3.4 summarizes the main figures for electrification since 2009.

↓ ***Table A3.4.*** *Electrical connectivity, 2009–2015*

Population (millions)	39.83	40.85	41.91	43.01	44.14	45.28	46.45
Total no. of households (millions)	9.04	9.34	9.64	9.96	10.29	10.63	10.98
Demand for new connections (millions)	n/a	0.29	0.31	0.32	0.33	0.34	0.35
No. of domestic connections (millions)	1.08	1.26	1.53	1.79	2.06	2.48	3.31
Annual rate of new connections (millions)	0.19 (21%)	0.18 (16%)	0.26 (21%)	0.27 (17%)	0.27 (15%)	0.42 (21%)	0.83 (33%)
No. of households per connection	1.83	1.79	1.76	1.73	1.70	1.67	1.62
Connectivity level (%)	19%	21%	24%	27%	30%	35%	44%
Theoretical population growth (%)	19%	22%	26%	30%	33%	40%	52%

Source: reference 7.

While about 5.5 million consumers were connected to the grid in 2017, about 4 million households currently lack access to electricity (8). It is expected that 3 million new users will be reached by extension of the traditional grid, while the remainder will have access through off-grid solutions, such as stand-alone solar systems and mini-grids. Grid expansion will take time and is not guaranteed in the near term; therefore, areas 15 km beyond existing infrastructure may be covered by temporary interventions such as stand-alone systems or mini-grids.

Electricity is currently generated by renewable energy (48%), hydroelectric power (39%) and thermal energy (13%). The current power generation system cannot provide sufficient primary reserve power, and load-shedding is often required to stabilize the frequency. Kenya Power achieved a "system average interruption frequency index" of 3.78 per customer per month, with a target of 4, and a "customer average interruption duration index" of 5.66 h, with a target of 6 h. These indices were corroborated by the results of a customer satisfaction survey in June 2017, which indicated that the decrease in the frequency of outages was approved by customers (satisfaction increased from 69.4% to 76.7%) (8).

The main challenge to future operations is to meet increasing requirements for reserve power and the growing peak load in the evening. As power generation is limited, considerable power shedding is likely for some time (9). A reliable supply is essential to minimize use of more polluting energy in low-income households. Revision of the tiered pricing structure to reduce power consumption by people in the higher income quintiles would ensure better access to power during peak load periods.

Pricing structure, taxation and subsidies

Electricity tariffs in Kenya have fluctuated during the past few years; for instance, domestic tariffs nearly doubled in some months. This is due mainly to highly fluctuating fuel cost charges and, to a lesser extent, the foreign exchange rate fluctuation adjustment, which change every month. The Government plans to reduce the tariffs by introducing new low-cost power sources (9). The "Last Mile Connectivity Project" subsidizes the electricity connection fee charged to household to reduce it from 35 000 KES (US$ 347) to 15 000 KES (US$ 148), to be paid in installments.

Carrying capacity and electricity demand for cooking, heating, lighting and cooling

The average consumption and rate of access per main power use by socioeconomic group in the Nairobi region are shown in Table A3.5.

↓ ***Table A3.5.*** *Electricity consumption per use and socioeconomic group*

Use	Consumption per use (kWh)					
	Urban			Rural		
	High income	Middle income	Low income	High income	Middle income	Low income
Lighting	1219	350	105	978	294	135
Cooking	311	412	297	359	270	304
Small kitchen appliances	981	706	519	788	594	668
Refrigeration	2607	1875	1380	2092	1577	1776
Space heating	107	77	57	86	65	68
Air conditioning	6845	4925	3623	5493	4141	4663
Sanitary water	2355	1695	1247	1890	1425	1605
Entertainment, computers	1555	1119	823	1248	941	1059
Dishwashing	581	771	308	466	352	396
Laundry	466	335	246	374	282	317
Water supply	121	87	64	97	73	82
House cleaning	119	86	63	96	72	81
Grooming	36	26	19	29	22	24
Fitness	933	671	494	749	565	636

Source: reference 7.

Electricity is used mainly for lighting in all consumer household categories. Heating water, air conditioning and space heating consume a great deal of power and electricity is not used for these reasons by consumers for whom cost is a factor. Thus, most households boil water for bathing, further increasing the demand for fuel, and a number of households, particularly at high altitudes, use cooking heat for space heating.

Barriers to increased penetration of electricity for cooking

Electricity is not more widely used for cooking because the supply is unreliable and of poor quality, because the cost is perceived as higher than that of other fuels, and because the cost of electric cooking stoves and appliances is high. Structural inadequacies of housing units mean that wiring and fitting do not allow for cooking. Another reason is a perceived danger of electrocution, due to experience of short-circuiting of other electrical appliances.

Biogas

Biogas has been promoted over the past 50 years by national and international organizations, and over 20 000 biogas systems are installed in the country. In 2009, the Kenya Biogas Programme projected installation of 8000 digesters in rural areas by 2013 (10). In the second phase of the programme, from 2014 to 2017, an additional 27 500 digesters of both traditional and more advanced designs were installed. Some of the biodigesters installed in Kenya operate below capacity or are currently in disuse because of management, technical, sociocultural or economic problems (10). Because of a lack of consolidated data on biogas production, it is difficult to determine the country's overall capacity (11).

The Draft Energy and Petroleum Policy 2015 (1) includes a strategy to promote use of biogas as an alternative to wood and kerosene for domestic and commercial energy. The strategy includes public awareness-raising; research on and development of biogas energy technologies; capacity-building programmes for installation of biogas plants

in communities and institutions, including prisons, schools and hospitals; appropriate fiscal incentives for local manufacture of plant and equipment; and large-scale production, storage and distribution.

Biogas is used mainly for cooking but also for lighting, electricity generation to power certain farm equipment and providing heat for chicken brooders and hatcheries. The market and supply constraints include lack of quality control (12), a poor dissemination strategy by promoters, the fact that biogas refilling is considered "dirty" by some people and scarce, fragmented promotion. Thus, the barriers to penetration are lack of awareness of the potential benefits of biogas technology, inadequate research on and development of biogas technologies, high cost of domestic and commercial biogas plant and equipment, inadequate capacity of biogas contractors and an insufficient legal and regulatory framework for biogas contracts.

Ethanol

In 2010, the Government prepared a strategy for introducing biofuel blends onto the market. Facilities for ethanol–gasoline blending have been completed in Kisumu and are to be followed by Eldoret and Nakuru; however, there are insufficient quantities of bioethanol feedstock. In most planned bio-fuel projects, sugarcane and sweet sorghum are the main feed-stock for ethanol, and jatropha, castor and other vegetable oil crops such as coconut, croton and cotton seed for biodiesel (13). The Kenyan ethanol industry includes Agro Chemical, Spectre International and Mumias, which had a combined production capacity in 2009 of over 340 000 L/day (14). Within the ethanol stove project of Safi Stoves, supported by Samsung Electronics, 1500 ethanol stoves have been distributed in Mombasa. A project launched in January 2018 is to distribute 12 000 subsidized ethanol stoves to over 200 000 refugees at the Kakuma refugee camp, and Rural Development Solutions is setting up an ethanol bottling plant at the coast.

Solar energy

A large-scale solar energy market has developed in Kenya to supplement the demand for electricity for houses and institutions that are remote from the national grid and for medium-temperature water heaters for domestic and commercial use. A study in 2014 by M-KOPA Solar and InterMedia (15) showed that 14% of the Kenyan population used off-grid solar energy as their primary source for lighting and charging. The World Bank estimated in 2017 (16) that 30% of households in Kenya that were off grid had a solar product. About 2.75 million qualified, verified solar products have been sold in Kenya since 2012, representing 23% of all sales in Africa.

The annual market for solar photovoltaic panels is estimated to be 500 kW and is projected to grow at 15%. Off-grid solar photovoltaic systems have been installed in about 1000 institutions across the country. Kenya has one of the most active commercial photovoltaic system markets in sub-Saharan Africa, with an installed photovoltaic capacity in the range of 4 MW. An estimated 300 000 rural households in Kenya have solar home systems, and 10 000–20 000 photovoltaic systems are sold annually (14).

The Solar Water Heating Regulations (2012), which came into effect in 2016, require that all premises under the jurisdiction of local authorities that require more than 100 L/day of hot water install and use solar heating systems. The demand for solar water heating is projected to grow to more than 800 000 units by 2020, representing an annual growth rate of 20%. The demand will come mainly from domestic, institutional and small commercial consumers, spurred by operationalization of the Regulations, 2012 (11).

The Energy Regulatory Commission has issued regulations for installation of solar systems, and Lighting Africa has helped the market to improve product standards. Kenya Renewable Energy Association are implementing a voluntary quality accreditation programme for solar system vendors and integrators. Other incentives for installation of solar systems are:

- a recommendation in the draft energy bill 2015 to establish a renewable energy resource advisory committee;

- issuance by the Ministry of Energy of the feed-in-tariff for solar-generated electricity to attract private sector capital;
- the Energy (Solar Water Heating) Regulations 2012 and the Energy (Solar Photovoltaic) Regulations 2012, which provide the policy framework;
- zero-rated import duty and removal of value-added tax on renewable energy equipment and accessories; and
- the requirements of the Kenya Standard Off-Grid Solar Photovoltaic Lighting Kits (KS 2542:2014).

Some of the barriers to exploitation of solar energy include high initial capital costs, little awareness of the opportunities and economic benefits and poor adherence to system standards by suppliers (17). Other barriers are uncertain land tenure, the high cost of reticulation, high costs of technologies and accessories, wide variation in designs and performance and lack of local standards, especially for solar cookers and concern about vandalism or theft of solar systems.

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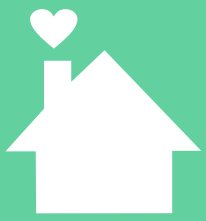

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