

Opportunities for transition to clean household energy in Ethiopia

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



ETHIOPIA

Getachew E Beyene
Abera Kumie
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World Health
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ISBN 978-92-4-151449-1

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Suggested citation. Beyene GE, Kumie A, Edwards R, Troncoso, K. Opportunities for transition to clean household energy: application of the Household Energy Assessment Rapid Tool: Ethiopia. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.

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Printed in Switzerland

Design and layout: Paprika, Annecy

Cover photo: John Wollwerth / Shutterstock

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Abbreviations and acronyms

CO	carbon monoxide
GDP	gross domestic product
GTP II	second Growth and Transformation Plan
HEART	Household Energy Assessment Rapid Tool
LPG	light petroleum gas
MDG	Millennium Development Goals
NGO	non-governmental organization
PM2.5	particulate matter $\leq 2.5 \mu\text{m}$ in diameter
ppm	parts per million
SDG	Sustainable Development Goal
WASH	water, sanitation and hygiene

Acknowledgements

This report was prepared by a team of consultants consisting of Getachew Eshete Beyene, Abera Kumie, Rufus Edwards and Karin Troncoso, with input from Waltaji Terfa Kutane and Goitom Gebremedhin at the WHO Country Office in Ethiopia. Input from local organizations and Government officials was instrumental for completing the report and is gratefully acknowledged. The report was reviewed by Heather Adair-Rohani and Jessica Lewis (Technical Officers), WHO Department

of Public Health, Environmental and Social Determinants of Health, Geneva, Switzerland. Editorial assistance was provided by Jonathan Mingle and Elisabeth Heseltine.

WHO is grateful to Bloomberg Philanthropies for funding the project to identify opportunities for transition to clean household energy in countries by application of the Household Energy Assessment Rapid Tool (HEART).

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.

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 Ethiopia.

Introduction

In Ethiopia, over 95% of households continue to rely on biomass fuels for cooking, which results in a high burden on health: air pollution is the largest single environmental risk factor for premature death in Ethiopia, and the deaths attributable to household air pollution are dominated by those due to lower respiratory infections in children. Respiratory illness among children is one of the leading causes of hospital admissions and deaths in Ethiopia (1, 2), and chronic obstructive lung disease is a growing concern among women, who are most heavily exposed to household pollution due to cooking with biomass fuel. Reduction of exposure during pregnancy and in the first 2 years of life should be a high priority.

The main energy issues in Ethiopia are:

- a growing gap between the supply of and demand for biomass fuels;
- adverse effects of household energy use on both health and the environment;
- increasing proportion of income spent on energy for cooking, particularly in urban areas;
- limited awareness of the link between health and household energy use; and
- inefficient coordination between the health and energy sectors.

The main barriers to use of clean fuel in Ethiopia are:

- low availability and reliability of fuel resources,
- the weak purchasing power of poor rural communities,
- little awareness of clean fuel options and technologies,
- little awareness about the safety of clean fuels,
- an underdeveloped market and
- the electricity pricing structure.

There are possibilities for a transition to clean fuels. Ethiopia is on the cusp of the development of both significant renewable energy and significant gas field resources, and the electricity supply is renewable, with plans for more generation;

however, total demand for electrical power is increasing by about 30% annually. Although Ethiopia has shown consistently high rates of growth in gross domestic product (GDP) over the past few years, efforts to reduce household air pollution are limited by wealth inequality. The affordability of clean fuel is a significant barrier for rural populations, who have the greatest burden of ill health, as they have limited purchasing power. In contrast, an increasing proportion of urban income is spent on cooking fuels, and fuel markets are well established.

Electricity is a viable option in urban and periurban areas, given the projected increase in generation capacity, if it is combined with price structuring to reach poorer households. In rural areas, solar lighting, solar electricity systems and mini-grids should be promoted, possibly in combination with higher tariffs for kerosene in order to eliminate its use. Nevertheless, the clean fuel options in rural areas, apart from biogas for households in which livestock are reared and with access to water, remain a significant challenge for infrastructure and cost. The estimated surplus production of ethanol (200 million L) in sugar refineries offers an option for both urban and rural households, particularly in areas adjacent to refineries; however, barriers of awareness and social acceptance remain to catalysing the market for wider adoption of electricity and ethanol. There are technical barriers to use of electric and ethanol stoves and increasing capacity for monitoring and evaluation in testing facilities. Although electric stoves are on sale in rural towns, resistance and induction stoves require significantly improved technology. Prototype electric induction injera stoves are being tested, but the move to production and penetration of local markets requires assistance. In rural communities where clean fuels are not yet available, health could be improved by constructing kitchens separate from the main house, with chimneys to ventilate emissions outdoors.

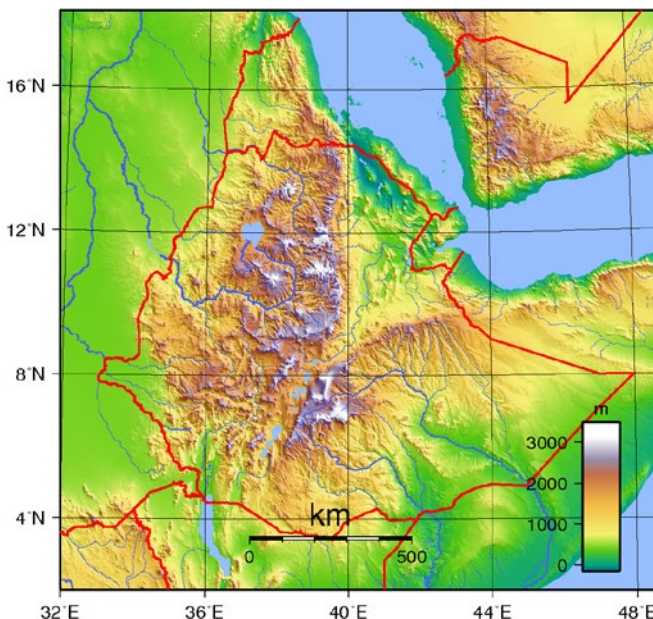
Country context

2.1 Geographical data

Ethiopia has a wide range of altitudes, from 100 m below sea level on the northeastern border to more than 4000 m above sea level in the country's mountain ranges. The plateau gradually slopes to the lowlands of Sudan on the west and Somali-inhabited plains to the east. Ethiopia's agro-ecological zones differ in terms of rainfall, soil types, altitude and other aspects, resulting in a wide variety of housing and cooking arrangements.

Ethiopia can be broadly categorized into: arids lands to the east and south, where the main livelihood is cattle herding; the western lowlands, where there are large uncultivated areas and a

small population; and the highlands, which are ideal for farming but where farmland is limited and rapidly eroded, with high population density (Fig. 1). Most of the country experiences a rainy season between June and September, during which 90–95% of Ethiopia's total annual crop is produced. This season is preceded by short rains between March and May, mainly in the northern highlands of Tigray and Amhara regional states, which are the main seasonal rains for pastoral and agro-pastoral areas in the south and southeast of the country, including the lowlands of Oromia in the south.



↑ **Fig. 1.** *Topographical map of Ethiopia*

Source: Sadalmelik 2007. Topographic map of Ethiopia, created with GMT from public domain GLOBE data (https://commons.wikimedia.org/wiki/File:Ethiopia_Topography.png, accessed 19 March 2018).

The country is a federal state comprising nine regional states and two municipalities. The Government structure is in two tiers, for the federal and regional levels. Each state has zones, districts (woredas), cities and neighbourhood administrations (kebeles). The regional states

have considerable autonomy in the management of their internal affairs. In each region, the district is the basic planning unit, and they have jurisdiction over the kebeles. All land is the property of the national Government and is leased, not sold, for development.

2.2 Demographic and economic data

2.2.1. Demography

Ethiopia is the second most populous country in sub-Saharan Africa, with an estimated population

of more than 100 million, of whom more than 80 million live in rural areas and 34% below the poverty line (3) (Table 1).

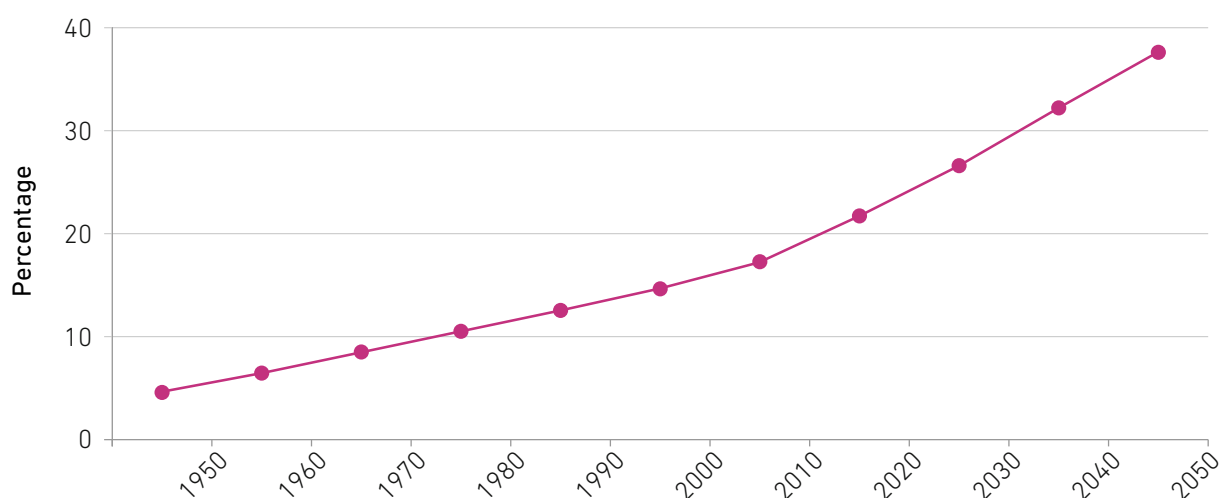
↓ **Table 1.** Demographic and economic indicators, Ethiopia, 2016

Indicator	Value	Reference
Crude death rate, number per 1000	33.6	4
Crude birth rate, number per 1000 population	9.2	4
Maternal mortality ratio, number per 100 000 live births	412	4
Infant mortality rate, number per 1000 live births	48	4
Child mortality rate, number per 1000 live births	67	4
Life expectancy at birth (years)	65	5
Total fertility rate per woman	4.6	4
Average household size (national census)	4.6	4
Annual population growth rate (%)	2.5	6
Urban population (millions)	19.5	7
Gross national income per capita (US\$)	660	5
Human development index	0.448 (2015)	8

Children aged ≤ 15 years represented about 42% of the population in 2015, while those over 64 years represented 3.5%. The distribution of regional populations varies widely. The largest regions, Amhara, Oromia, Southern Nations, Nationalities and People's and Tigray, together have 86% of the population and a larger population density than the agricultural regions (Afar, Benishangul-Gumuz, Gambella and Somali).

2.2.2. Urbanization

The current 935 urban settlements are expected to grow, some becoming metropolitan areas; smaller rural towns are also growing, and the current urban population is expected to double by 2050 (Fig. 2). The demand for fuel energy for cooking, heating and lighting will also increase substantially, thereby increasing the demand on the natural environment, which will further affect development.



↑ **Fig. 2.** Proportion of urban residents in the total population, Ethiopia, 1950–2050

Source: reference 5.

2.2.3. Gross domestic product

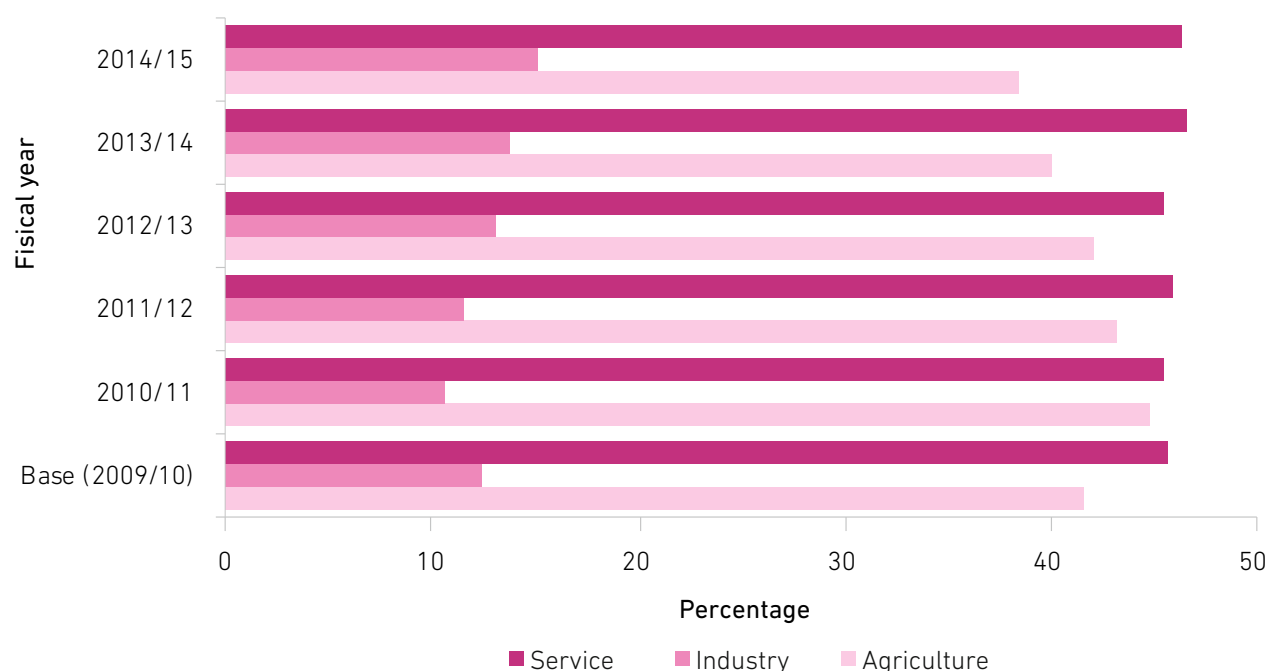
Ethiopia's economy has developed annually since 2004 (Fig. 3), and the annual gross domestic product (GDP) grew by an average of 10.6% in 2004–2016. The agricultural sector contributed 36.7% of the country's GDP in 2015, 90% of export

earnings and 85% of employment; however, this sector is characterized by subsistence farming, almost entirely rain-fed, and pastoralism, with very little technological input. As a result, the performance of the sector has been generally poor, with an annual growth rate of about 8% in recent years (Fig. 4).



↑ **Fig. 3.** Annual percentage growth in gross domestic product

Source: reference 9.



↑ **Fig. 4.** Percentage share of GDP by major economic sector, Ethiopia, 2009–2010 and 2014–2015

Source: reference 10.

The country's second Growth and Transformation Plan (GTP II) includes targets to sustain a rate of increase in the GDP of 11% by growth of 8% in agriculture and 20% in industry by 2019–2020 (10).

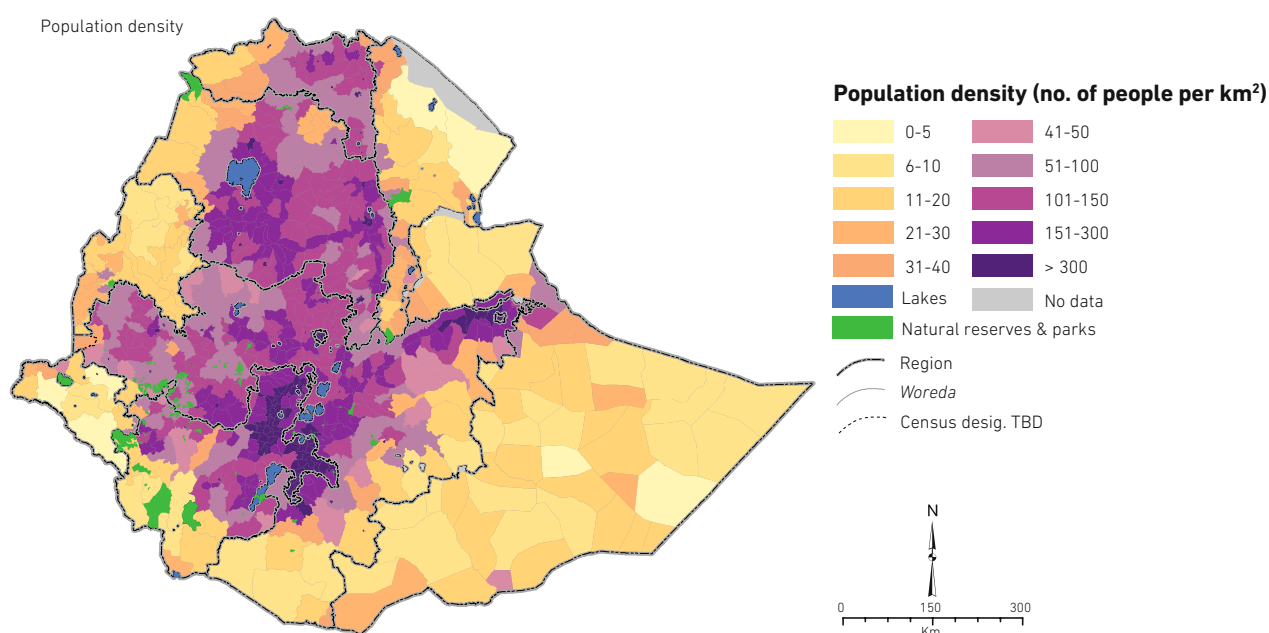
population has the least wealth as compared with the urban population, which affects the access of rural households to clean energy in the short run.

2.2.4. Disparities in wealth

Disparities in wealth are seen by region and residence. Generally, urban administrations (Addis Ababa, Dire Dawa and Harari) and the large regions (Amhara, Oromia, Southern Nations and Tigray) are more wealthy than the agricultural regions (Afar, Somali, Gambella and Benshangul). The rural

2.2.5. Population distribution

The population of Ethiopia in 2016 was 102.4 million people, with an annual growth of 2.53% (11). Most of the population lives in the highlands, and Oromia, Amhara and Southern regions have 80% of the total population (Fig. 5). The population-density map shows strong geographical clustering in the highlands and along major road networks.



↑ **Fig. 5.** Population density, Ethiopia

Source: reference 12.

Population & Housing Census, Atlas of Ethiopia 2007, International Food Policy research Institute (IFPRI).

2.2.6. Infrastructure

Road development

Ethiopia has undertaken a large-scale road sector development programme since 1997, with an increase in the road network from 26 550 km in 1997 to 110 414 km in 2015, representing a 316% increase in 18 years. The number of areas further than 5 km from an all-weather road decreased from 64% in 1997 to 37% in 2015, and the average distance to the nearest all-weather road decreased from 21 km to 5 km (13).

Communications

Telecommunications have expanded rapidly, with about 57 million mobile phone subscribers.

It is anticipated in GTP II that 103.6 million subscribers will be connected by the end of 2020.

Education services

School infrastructure plays key role in Ethiopian socioeconomic development. Numerous studies indicate that education reduces the number of cases of diarrhoea (13, 14), increases the number of deliveries in institutions (15) and reduces exposure to household air pollution (16, 17). After concerted efforts to increase the number of schools, Ethiopia now has more than 32 000 primary schools, and 100% of children aged 7 years start grade 1. Access to secondary education is much lower in rural areas. The gender parity index increased from 0.8 in 2009–2010 to 0.94 in 2013–2014 as a result of extensive campaigns (18).

2.3 Energy production and consumption

2.3.1. Availability of energy and capacity for generation

Ethiopia is on the cusp of development of both significant renewable energy and significant gas

field resources. The country is in a relatively unique position, as electricity is produced exclusively from renewable sources, such hydropower (89.7%) and wind power (7.6%) (Table 2). (For more information on energy sources in Ethiopia, see Annex 1.) The total demand for electrical power in Ethiopia is, however, increasing by about 30% annually.

↓ **Table 2.** *Potential and exploited sources of energy in Ethiopia*

Source	Unit	Exploitable reserves	Amount	Exploited
Hydropower	GW	45	3.18	~ 17
Solar (day)	kWh/ m ²	5.2		< 1
Wind (power speed)	GW m/s	1350 > 7 ^a	0.324	< 1
Geothermal	GW	7	0.0073	< 1
Wood	Million T	1120	560	50
Agricultural waste	Million T	15–20	~ 6	30
Natural gas	Trillion m ³ (2013)	< 0.1	–	0
Coal	Million T	> 300	–	0
Oil shale	Million T	253	–	0
Biogas	Households	1–3 million	17 869	< 1

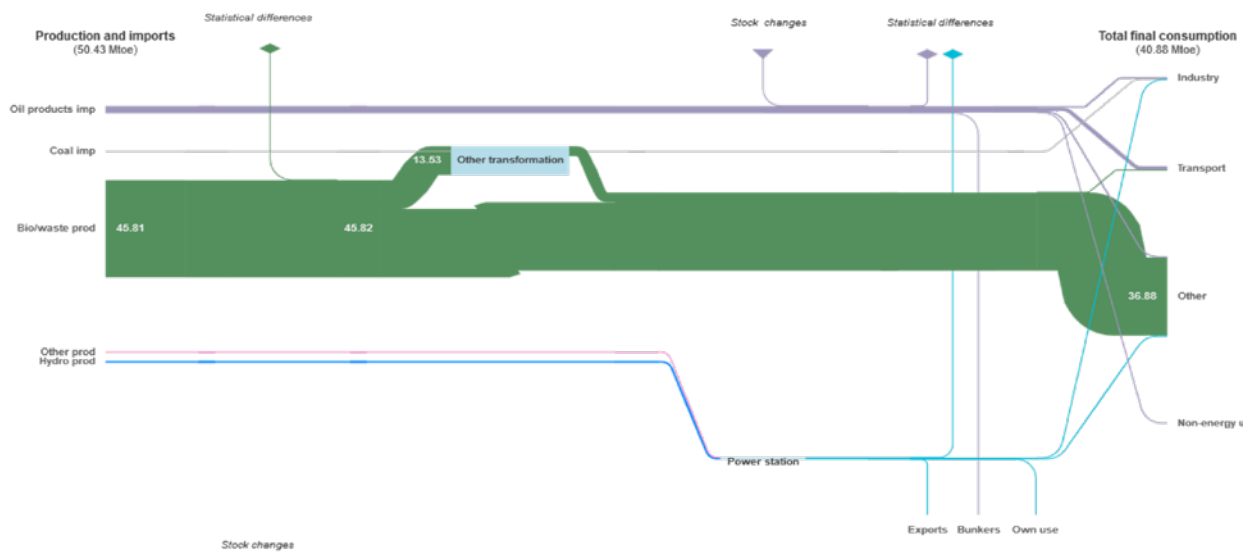
Sources: references 19–22.

^a Potential wind GW energy > 7 m/s, a measure of usable wind energy.

The amount of diesel power currently used is 143 MW, geographical access to the electricity grid is about 56% and household connectivity about 25%. Estimated electricity consumption per capita is 100 kWh/a (19). Ethiopia is a major exporter of renewable energy to eastern Africa and is connected with Sudan and Djibouti through 230 kV, with power flows up to 250 MW and 90 MW, respectively. A number of projects are in place to increase the country's energy production (19).

2.3.2. Energy production and consumption

A Sankey diagram of the energy balance of Ethiopia in 2015 (Fig. 5; 3) shows the massive role of biofuels and waste (solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste) in national energy consumption, indicating that households are responsible for a substantial proportion.



↑ **Fig. 6.** Sankey diagram of energy production, imports and consumption in Ethiopia, 2015
 Source: reference 3.



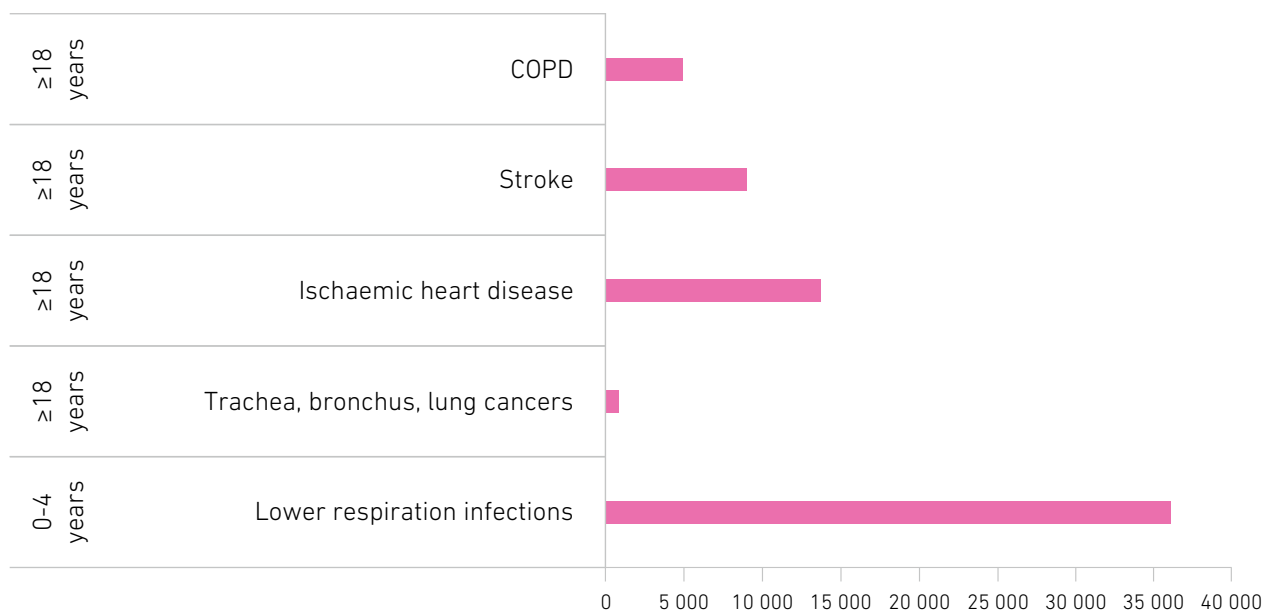
📷
 Solid fuel oven and stove
 Credit: Heather Adair-Rohani

Health sector

3.1 Burden of disease

Air pollution is the single largest environmental risk factor for premature death in Ethiopia, and household air pollution due to burning of solid fuels is responsible for over 65 000 premature deaths and more than 3.1 million disability-adjusted life-years per year (23). The deaths attributed to household air pollution are due mainly to lower respiratory tract infections (36 144

cases in 2016), with the greatest impact in the first 6 days of life. Household air pollution is also a risk factor for chronic obstructive pulmonary disease, lung cancer and cardiovascular disease in adults (24) (Fig. 7) and may be a risk factor for diseases such as tuberculosis and various adverse birth outcomes



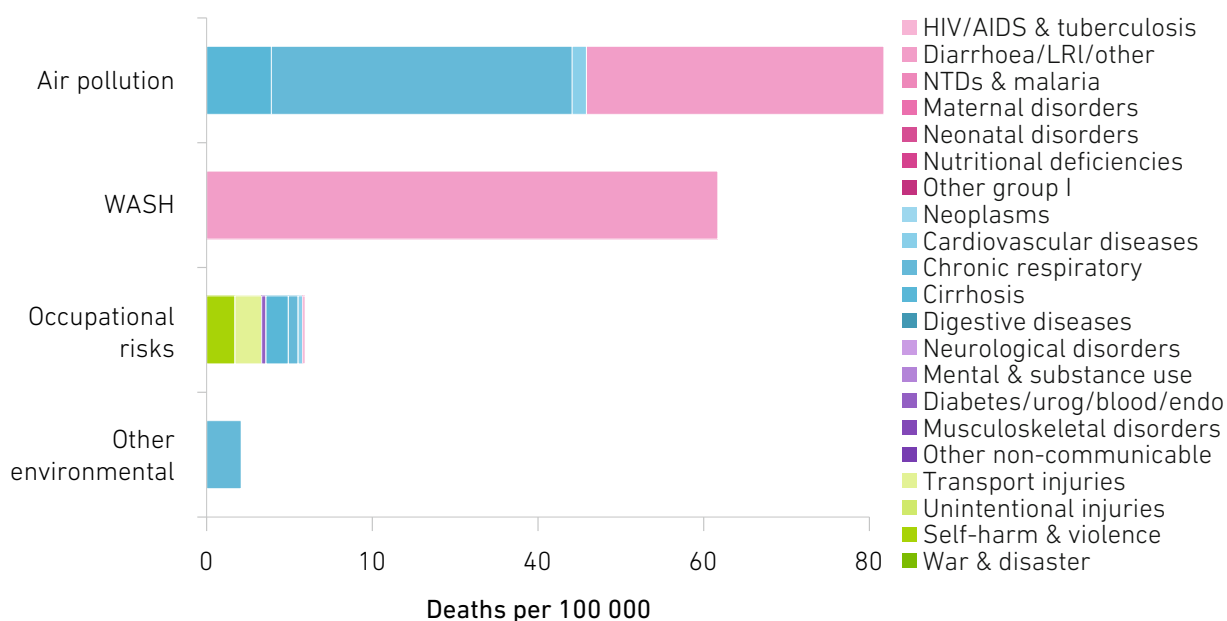
↑ **Fig. 7.** Numbers of deaths attributable to household air pollution, Ethiopia

Source: reference 24.

COPD, chronic obstructive pulmonary disease

In 2016, air pollution was the most important environmental risk factor for chronic respiratory

and cardiovascular diseases, stroke and pneumonia (Fig. 8).



↑ **Fig. 8.** Environmental risk factors for death in Ethiopia, 2016

Source: reference 25.

WASH, water, sanitation and hygiene; LRI, lower respiratory tract infection; NTD, neglected tropical disease; urop, urogenital; endo, endocrine metabolic blood and immune disorders

The prevalence of symptoms of acute respiratory illness within the previous 2 weeks decreased from 24% in 2000 to 7% in 2016 (4, 26–28). The prevalence of symptoms was, however,

much higher in vulnerable groups such as rural (20.6% (29)) and urban slum populations (23.9% (30)).

3.2 Local studies of health effects of household air pollution

Few local studies of exposure to household air pollution as a risk factor for respiratory illness were found. The use of polluting fuels in an urban slum was associated with an increase in the prevalence of acute respiratory illness in one survey, with an odds ratio of 2.97 (95% confidence interval, 1.38;3.87) in households in which biomass fuel was used and 1.96 (0.78;4.89) in those in which kerosene was used, relative to cleaner fuels (30).

Low socioeconomic status, little education, poor ventilation and use of biomass fuel in the kitchen were associated with self-reported acute respiratory illness, defined as cough accompanied

by fast breathing, in a study in a rural community (29). Malnutrition, use of charcoal for cooking, carrying a child on the back while cooking and living in crowded house were determinants of pneumonia as diagnosed by the presence of cough, fast breathing and/or danger signs including chest indrawing and stridor among children under 5 years (31). Overall, acute respiratory illness was strongly linked to characteristics such as use of biomass fuels, crowded living and low socioeconomic status.

Maternal and child health and nutrition programmes and assessments of environmental health risk are summarized in Annex 2.

3.3 Health service infrastructure and access

Extension of the road infrastructure has given the Ethiopian population better access to health facilities, and, currently, 100% of the population has access to a health facility. There are 16 447 health posts, 3547 health centres and 189 hospitals in Ethiopia (32). Although access to health services by geographical location has been greatly improved, major indicators of maternal and child health remain high. The number of physicians was 0.2 per 10 000 population (9), which is lower than the WHO recommendation of 23 per 10 000 as a threshold for achieving the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) to provide basic health services (33). Nationally, 22% of all health facilities, 70% of hospitals and 80% of health centres offer all basic maternal and child health services (34).

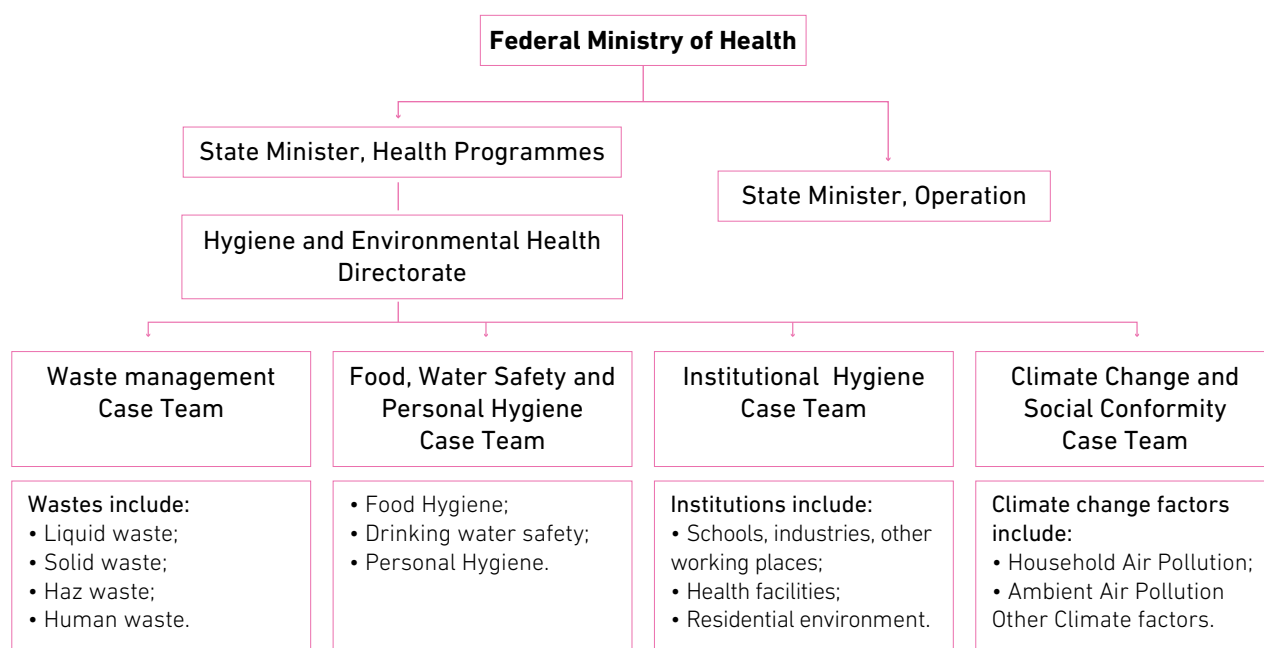
Only 26% of mothers gave birth at a health facility in 2016 (4). An adequate water supply and sanitation are still major challenges: in 2016, 30% of the health facilities surveyed had access to a clean water supply and 69% to sanitation. Only about one fourth of health facilities have a regular, uninterrupted supply of electricity, and access to power is the least regular in remote health posts (10%) (35). Ethiopia has introduced a strategy to protect the life of mothers during delivery, which consists of an ambulance service and a communication network of land lines and mobile phones. Transport for emergencies was available in 84% of health facilities, and 27% had access to communication equipment (functioning land lines, mobile phones, wireless telephones and radios) (35).

3.4 Health sector policies and programmes on air pollution

The Constitution of Ethiopia (1993) enshrines the right to live in a clean, healthy environment (Article 44) and stipulates that the aim of policies is to provide access to public health and education, clean water, housing, food and social security for all Ethiopians (Article 90). The Ministry of Health has two strategies for health and the environment: the National Hygiene and Environmental Health Strategy and the Integrated Urban Sanitation and Hygiene Strategy. These strategies are implemented through memoranda of understanding signed by seven ministries and organizations and through steering and technical committees, and these interministerial partnerships can be

called upon to deliver and promote clean energy technologies. Both strategies emphasize actions and coordination for management of air, soil and water pollution. Household air pollution is well represented in these strategies as an emerging, neglected concern.

The Ministry of Health included an environmental health team within the Directorate of Health Extension and Primary Health Services. The team has currently become an independent Hygiene and Environmental Health Directorate for national issues of hygiene, sanitation and environmental health. It has a Climate Change and Social Conformity Case Team to address issue related to air pollution (Fig 9).



↑ **Fig. 9.** Structure of the Ministry of Health, including the Environmental Health Directorate

Source: Compiled from data from the Ministry of Health.

The long-term health sector transformation plan (2015–2016 and 2019–2020) addresses health needs, with a focus on improving maternal and child health. It ensures regular activities in health facilities and introduces initiatives such as

community integrated management of neonatal and child illnesses and safe, clean deliveries. It also includes national environmental health strategies to change waste management and mitigate air pollution.



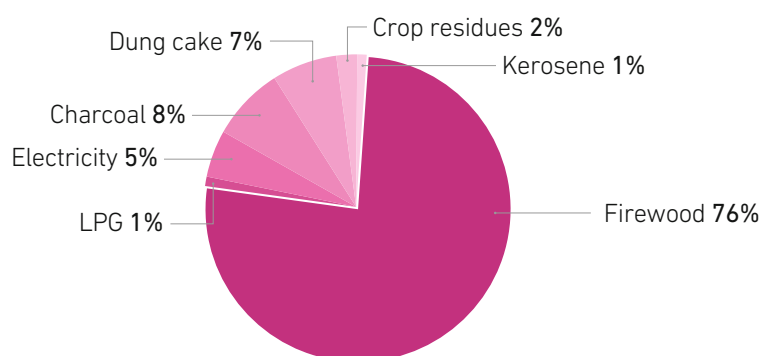
Outdoor kitchen with stone stove
Credit: Heather Adair-Rohani

Current household energy use

4.1 Household use for cooking

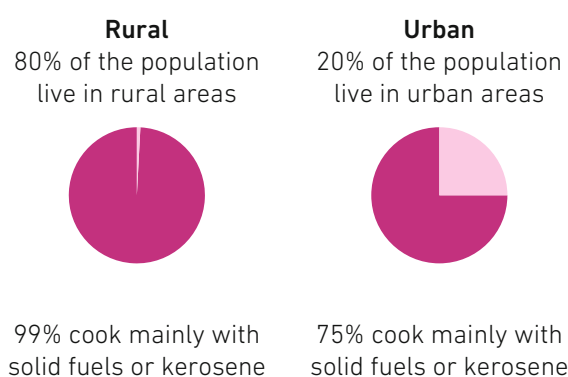
In about 95% of Ethiopian households, cooking is done with polluting fuels and technologies, especially firewood (4), and the proportion is almost 100% in rural areas (Figs 10 and 11). Although urban households use less polluting fuel

and technology, they still use mostly biomass: 38% firewood and 30% charcoal. In urban areas, clean fuel and technology are used in about one fourth of homes, as about 23% cook with electricity and 1% with liquified petroleum gas (LPG).



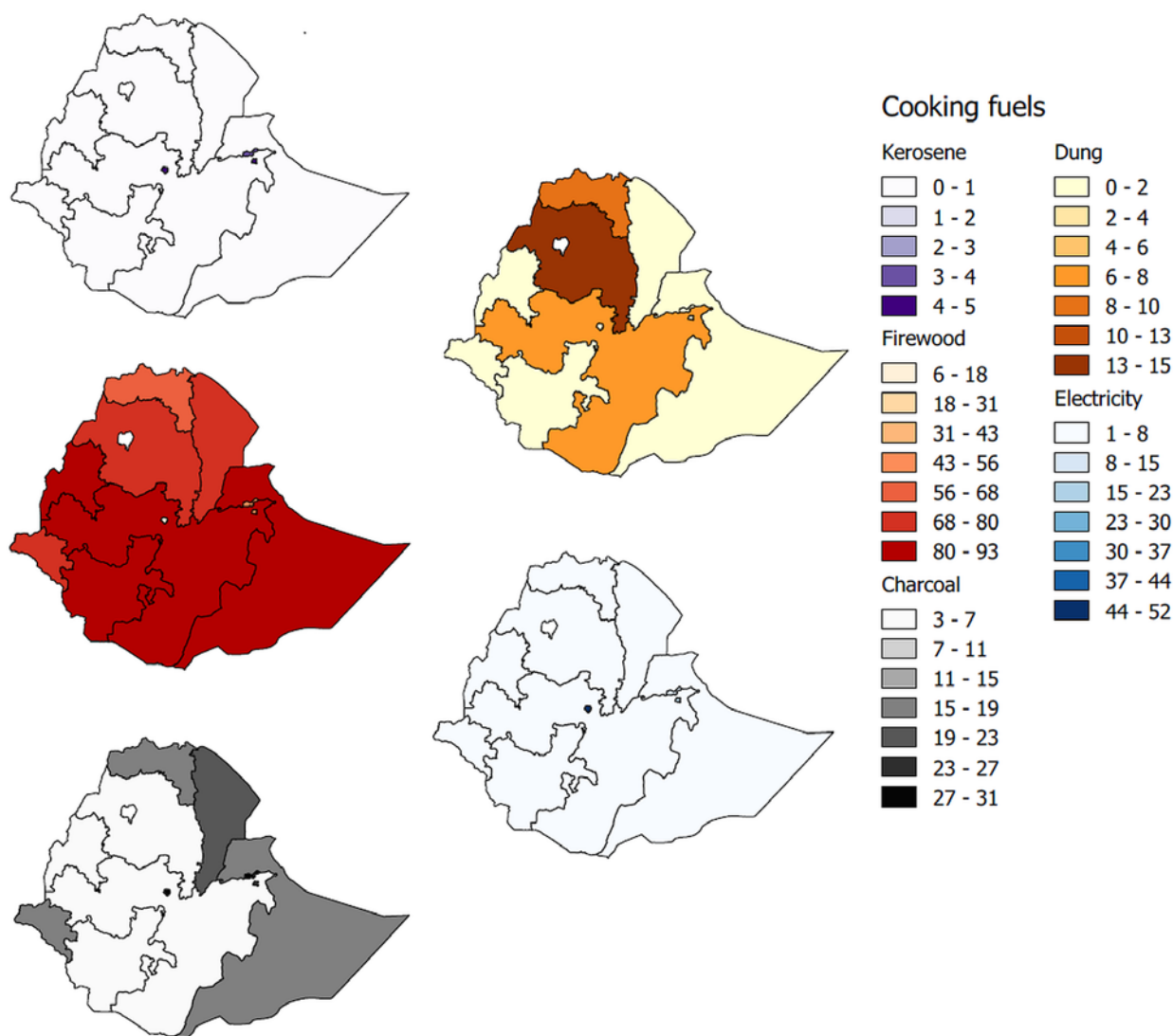
↑ **Fig. 10.** Cooking fuels and technologies used in households in Ethiopia, 2016

Source: reference 4.



↑ **Fig. 11.** Rural and urban use of cooking fuels and technologies in households in Ethiopia, 2016

Source: reference 4.



↑ **Fig. 12.** *Cooking fuels and technologies used in households in Ethiopia by region 2016*

Source: reference 4.

Gas fuel has very low penetration in Ethiopia, although gas production is projected to become available in 2019. Because a large proportion of primary energy is obtained from biomass, the fraction of non-renewably harvested biomass, a measure of unsustainable use of biomass resources, is estimated to be 62%, which is very high (36).

Charcoal is used daily for cooking and during the coffee ceremony in almost all urban households. It is also commonly used for heating indoors in urban households, particularly during the rainy season.

Cow dung is used mainly for baking injera and is traditionally used for baking bread during major holidays, even in Addis Ababa, although its use has decreased recently because of limited supply. For more details on the fuels used for household energy, see Annex 3.

Household air pollution has been measured in a number of limited studies in Ethiopia. In a survey of 59 kitchens in an Addis Ababa slum community, the mean concentration of particulate matter measuring $2.5 \mu\text{m}$ (PM_{2.5}) was $818 \mu\text{g}/\text{m}^3$, with higher concentrations in houses in which solid fuel was used (37). Measurements of nitrogen dioxide in 3300 houses showed that those with

wood stoves had significantly higher levels than those in which cooking was done with dung or crop residues (38, 39). In households in Addis Ababa in which wood was used for cooking, the mean 24-h level of PM_{2.5} was 793.1 µg/m³, and the 8-h level of carbon monoxide (CO) was 16.1 parts per million (ppm) (40). All of these pollutant levels exceeded the interim WHO criteria.

Personal exposure to air pollution was measured in only one study in Ethiopia, which assessed exposure during a traditional coffee ceremony. The geometric mean level of respirable PM_{2.5} was 1028 µg/m³ and that of CO was 29 ppm over 60 min (41), much higher than WHO guideline levels. The coffee ceremony is performed two or three

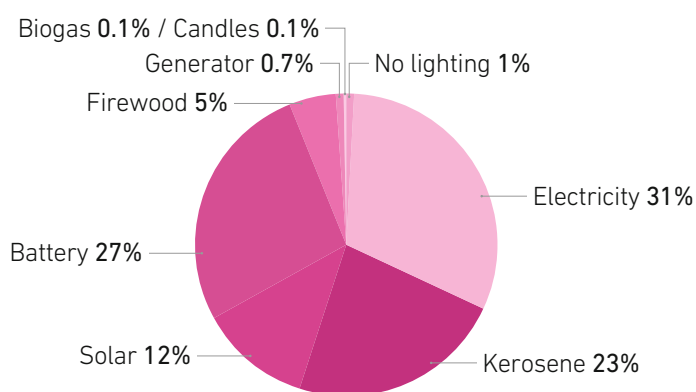
times a day and may therefore be a source of high exposure, especially for women and children.

In a study in nine houses in Addis Ababa, the 48-h median PM_{2.5} and CO concentrations were 330 µg/m³ for kerosene stove users and 25.1 ppm for charcoal stoves, respectively. Introduction of an ethanol stove into the same houses reduced the pollution significantly, by 58% and 72% for PM_{2.5} and CO, respectively (42). When ethanol cooking stoves were introduced into refugee camps to replace wood and charcoal, the levels of PM_{2.5} and CO were reduced to much lower levels (43, 44). (See Annex 4 for the results of more studies on household air pollution conducted in Ethiopia.)

4.2 Household use for lighting

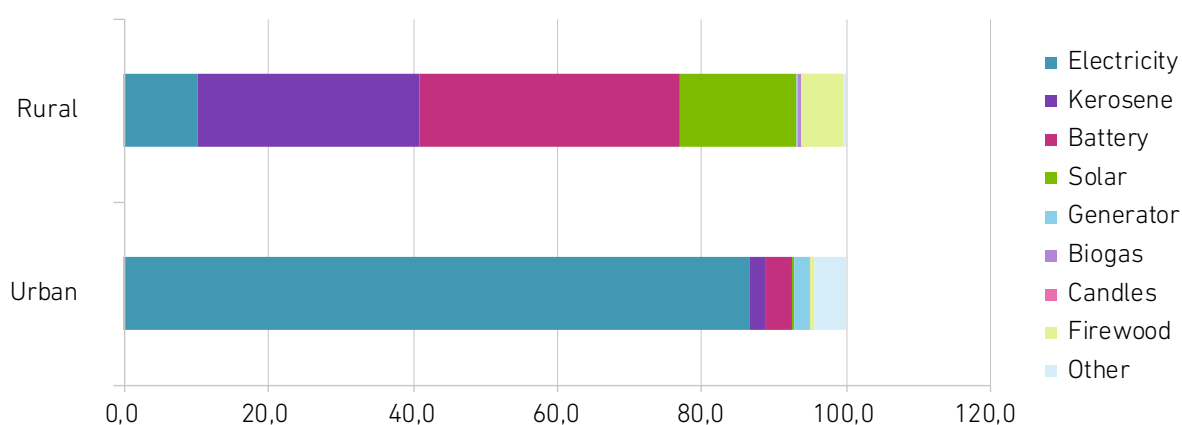
Clean fuels and technologies are used for lighting in the majority of households in Ethiopia, with electricity, battery-powered lanterns and solar-powered lights (Fig. 12). Almost 30% of households, however, use polluting, harmful fuels and technologies for lighting, including kerosene and wood.

More households in urban areas use of electricity for lighting (87%), while lighting in rural areas is dominated by use of kerosene (31%) and electric batteries (36%) (Figs 13 and 14). One reason for the relatively low use of kerosene may be that Ethiopia has removed subsidies for this fuel, raising the cost three times, and many rural households have shifted to solar lighting.



↑ **Fig. 13.** *Fuels and technologies used for lighting in Ethiopia, 2016*

Source: reference 4.

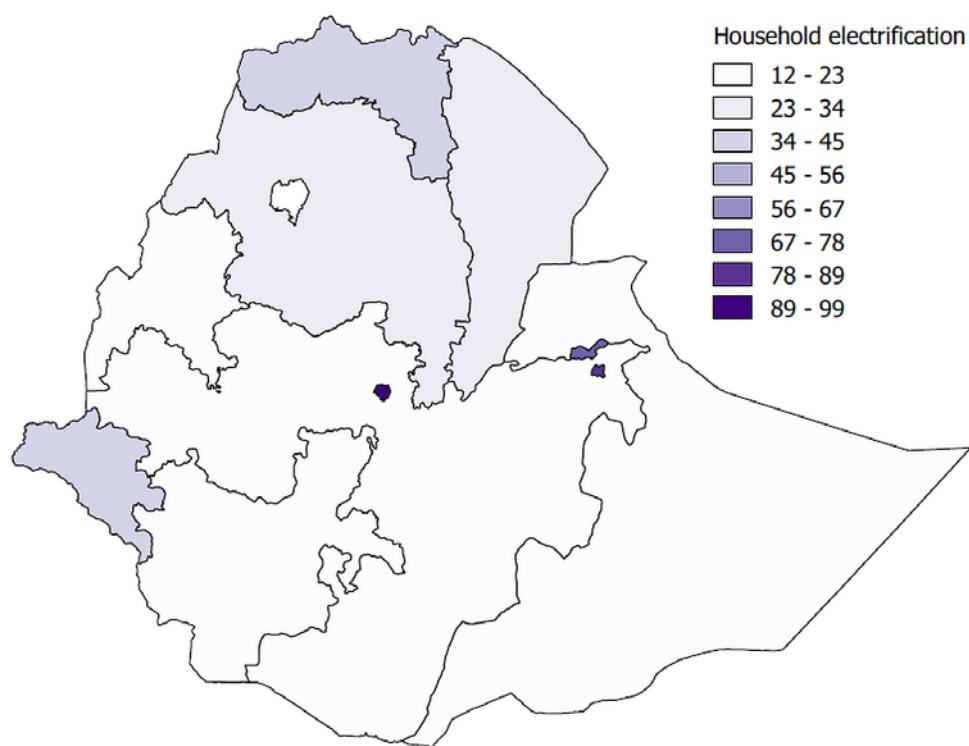


↑ **Fig. 14.** Lighting fuels and technologies used in urban and rural Ethiopia, 2015

Source: reference 45.

Access to electricity is found mainly in large urban areas; rural areas are largely unelectrified and use a mix of kerosene, electric batteries and solar

energy (Fig. 15). Ethiopia has ambitious plans to extend electricity access by using its hydropower potential.



↑ **Fig. 15.** Proportions of households with access to electricity, by region, 2016

Source: reference 4.

4.3 Household use for heating

Firewood is used for space heating in high-altitude rural areas where the temperature can drop to freezing-point at night and during the rainy season. Thus, home heating is another potential source

of household air pollution in Ethiopia in certain areas. Unfortunately, the use of different fuels for household heating has not yet been assessed in national surveys.

4.4 Perceived safety of household energy

Little is known about burn injuries in Ethiopia, however, the limited data available indicate that household energy use plays a major role. Records of inpatient admitted for burns in Attat Hospital (West Shoa Province) in 1983–1989 show that the home is the commonest site of burn injuries, and children are the commonest victims (46). Adult burns were related to cooking and epilepsy. The proposed preventive measures included: raising fires off the ground to create a physical barrier to inadvertent contact, making kerosene lamps more stable and encouraging education in

home safety. As most burns are related to fires in households, women's groups may be useful for disseminating education on burn prevention and first aid (46). A cross-sectional survey of 7309 individuals in 1390 households in Mekele town also showed that the highest incidence was in children under 5 years of age and that 81% of burns occurred in the home from household energy use (47). Education about burn prevention and first aid measures was recognized as a high priority.

Stakeholder organization and coordination

5.1 Government agencies

5.1.1. Ministry of Water, Irrigation and Electricity

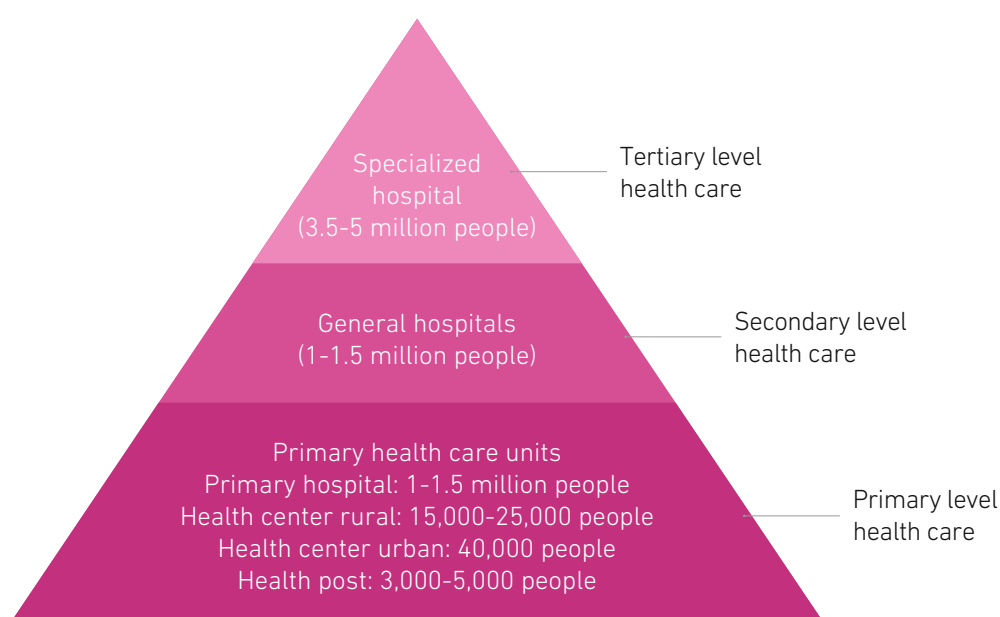
The Ministry of Water, Irrigation and Energy is in charge of the energy sector and is responsible for regulatory policy and decision-making, energy operations, implementation and supervising other government agencies and enterprises, including those described below.

The Directorate for Energy Studies and Development is responsible for the energy sector strategy. It is directly involved in planning electrification and worked on the national electrification strategy and the off-grid master plan. The Directorate is the source of data and information on energy. The Directorate for Alternative Energy Technology Development and Promotion is responsible for manufacturing, laboratory work and training in alternative energies (biomass, solar, wind, mini-hydro and others) and has distributed over 45 000 home systems for solar energy through a rural electrification fund. The Ethiopia Energy Authority regulates energy efficiency and conservation and the electricity sector, issues technical codes, standards and directives and commissions programmes and projects on energy efficiency. The Authority delegates its mandates to regional governments to better deliver regulatory services

to and promote energy efficiency and conservation services in the economy. The Ethiopian Electric Utility works in the construction and maintenance of electric distribution networks and purchase of bulk electric power and sells electrical energy to customers. It also proposes amendments to electric tariffs and related activities. Ethiopian Electric Power undertakes feasibility studies and surveys of electricity generation, constructs and upgrades transmission and substations, operates and maintains electricity generation and transmission, leases electricity transmission lines, sells bulk electric power, ensures universal access and conducts other activities to achieve its purpose in accordance with Government economic and social development policies and priorities.

5.1.2. Ministry of Health

The Ministry of Health oversees a three-tier system to deliver health care in Ethiopia (Fig. 16). The first level is a district health system covering 60 000–100 000 people, consisting of a primary care hospital, health centres and five health posts for each hospital, each serving 3000–5000 people. The district health system is associated with a general hospital (level 2) and specialized hospitals (level 3) (Fig. 16).



↑ **Fig. 16.** *Three-tier health delivery system, Ethiopia*

Ref: HSDP IV (Health Sector Development Programme IV 2010/11 – 2014/15; page 75)

5.1.3. Ministry of Environment, Forestry and Climate Change

The Ministry is responsible for realization of the environmental rights, goals, objectives and basic principles enshrined in the Constitution and of the environment policy of Ethiopia. It acts by coordinating appropriate measures, establishing systems, designing programmes and mechanisms for human welfare and the safety of the environment. It is also responsible for synergistic implementation and follow-up of international and regional environmental agreements, including those on hazardous chemicals, industrial wastes and anthropogenic environmental hazards, to which Ethiopia is a party.

The Ministry's environmental policies with regard to energy include intersectoral planning and development, in which energy development is integrated with energy conservation, environmental protection, sustainable use of renewable resources, promotion of the development of renewable energy sources and reduction of the use of fossil energy. The Ministry also supports technical and social research on the design of improved stoves and promotes the manufacture

and distribution of charcoal and biomass stoves. It has a mandate to develop and adapt energy sources and technologies to replace biomass fuels in order to avoid deforestation; this extends to testing and disseminating improved stoves, kilns, solar cookers and solar heaters. Other household energy-related functions include strengthening the capacity of Federal and regional energy agencies in research, planning and project implementation; establishing a centre for testing efficient alternative energy sources, technologies and appliances; and promoting and assisting the private sector in assembling and manufacturing energy development facilities and end-use appliances. The Ethiopian conservation strategy is summarized in Annex 5.

5.1.4. Ministry of Urban Development and Housing

Until recently, there were few national policies for coordinating housing and urban development. In 2005, the Council of Ministers approved a consolidated urban development policy to bring together the small-scale initiatives of regional governments and cities since 2000. They also created the Ministry of Works and

Urban Development to guide development of the country's urban areas and to conduct studies on urbanization patterns. Within this Ministry, the National Urban Planning Institute is responsible for preparing physical urban development plans, the Housing Development Bureau implements the integrated housing development programme, including micro- and small enterprise development programmes, and the Urban Development Support Services address financial planning, human resources and capacity-building (48). See Annex 6 for additional details of housing programmes in Ethiopia.

5.1.5. Other ministries

The Ministry of Finance and Economic Development is in charge of economic policy, planning and public finances.

The Ministry of Mines, Petroleum and Natural Gas is in charge of regulatory policy and decision-making for mining, petroleum and natural gas operations, and supervising other Government agencies and enterprises. The two directorates directly related to the energy sector are the Biofuel Development Coordination Directorate, which is responsible for coordinating biofuel development and use, and the National Strategic Petroleum Reserve Administration, an arm of Government that manages and administers strategic reserve depots located throughout the country to ensure a sustained supply at times of sudden shortages;

The Ministry of Trade sets retail prices and regulates the distribution of petroleum products. At regional level, energy activities are supported mainly by regional bureaus and other regional institutions.

5.2 Development strategies and flagship programmes

5.2.1. National strategy for access to electricity

The Government has embarked upon a national project to increase access to electricity and other modern energy sources. According to the Ministry of Water, Irrigation and Electricity (19), the Government launched an ambitious official electricity strategy in November 2017 – the Ethiopian integrated electrification road map (worth US\$ 1.5 billion) – with support from the World Bank (US\$ 350 million) to reach 100% (65% on-grid and 35% off-grid) of the population by 2025. It is not clear whether the electricity will be sufficient for household cooking, although it would provide reliable power for lighting. This strategy follows the Electricity Feed-in-Tariff Law (2012), which encourages diversification of the power in the national grid, thus making the power supply

more reliable and less vulnerable to weather and market conditions. The aim of the programme for alternative energy development and promotion is to use the country's abundant renewable energy sources and technologies by adopting or innovating new technologies. Annex 7 provides a list of the national and international energy projects currently under way in Ethiopia (49).

5.2.2. National energy policy

The first national energy policy was issued in March 1994 and remains the main policy for the energy sector. The aim of the policy is to ensure household energy by promoting agro-forestry, increasing the efficiency with which biomass fuels are used and facilitating a shift to more use of modern fuels. With this policy, the country

will rely mainly on hydropower to increase its electricity supply but also use its geothermal, solar, wind and other renewable energy resources as appropriate and further explore and develop oil and gas reserves. The policy stabilizes the price of household energy by increasing the supply of alternative fuels and relieving the pressure on wood.

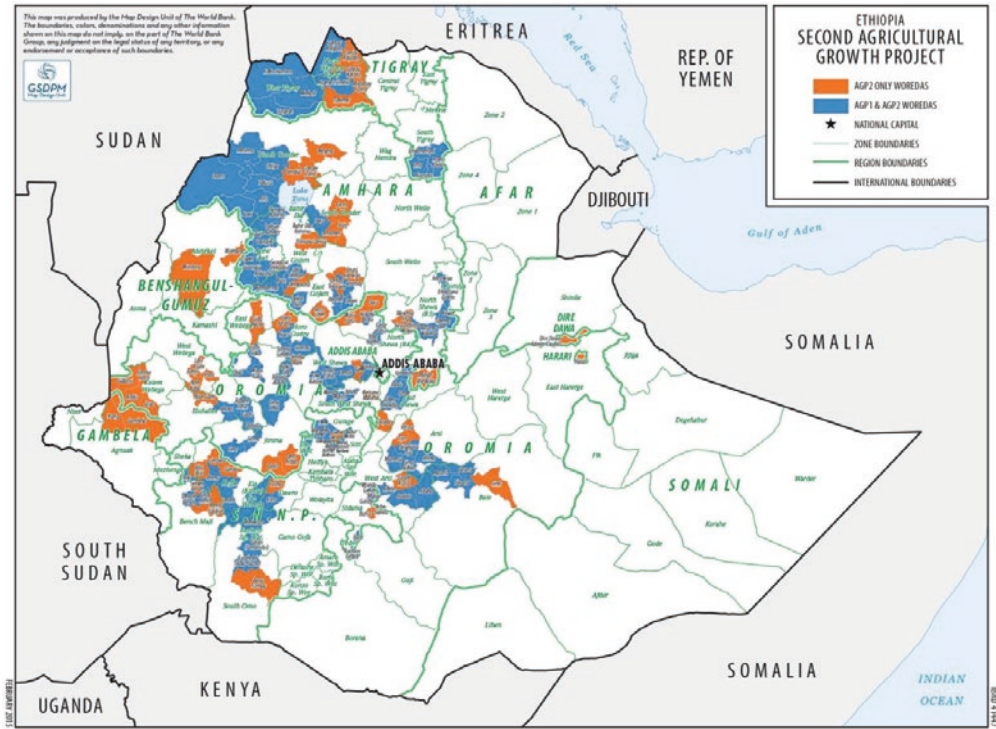
5.2.3. Climate-resilient green economy

A climate-resilient green economy is a strategy of the Ethiopian Government designed to protect the country from the adverse effects of climate change and to build a green economy that will help it to realize its ambition of reaching middle-income status before 2025 (50). The objective of the strategy is to identify opportunities that could help Ethiopia reach its ambitious growth targets (stipulated in GTP II), while keeping greenhouse gas emissions low. The will require increased agricultural productivity, a strengthened industrial base and greater export growth. The strategy

follows a sectoral approach and has so far identified and prioritized more than 60 initiatives that could help the country to achieve its development goals while limiting 2030 greenhouse gas emissions to around today's 150 Mt of CO₂, which will be less than the estimated 250 Mt of CO₂ to be expected in a conventional development pathway. The green economy plan is based on four pillars:

- Improve crop and livestock production practices for greater food security and more farmer income while reducing emissions (Fig. 17).
- Protect and re-establish the economic and ecosystem services of forests, including as carbon stocks.
- Extend electricity generation from renewable sources of energy for domestic and regional markets.
- Transition to modern, energy-efficient technologies in transport, industrial sectors and buildings.

The green economy strategy has prioritized programmes for sustainable forestry and reducing the demand for firewood by distributing fuel-efficient stoves or alternative-fuel stoves for cooking and baking (such as electric, LPG and biogas stoves).



↑ Fig. 17. Agriculture growth programme areas, Ethiopia

Source: reference 51.

5.2.4. Growth transformation plans

Ethiopia's Growth Transformation Plans lay out objectives for 5-year periods. After implementation of two consecutive poverty reduction plans – the Sustainable Development for Poverty Reduction Programme and the Plan for Accelerated and Sustained Development to End Poverty – the Government launched the first Growth and Transformation Plan (GTP I) as a medium-term strategic framework for 5 years from 2011. It was followed by the second Plan (GTP II) for 2015–2020 (10). A major objective of GTP I was to attain the MDGs, with an ambitious GDP growth rate of 11–14% per year through investments in agriculture, industry and infrastructure. The second Plan is to sustain economic development, secure social justice and increase per capita income to that of a middle-income country by 2025. GTP II promotes green development to meet the country's demand for energy by providing a sufficient, reliable power supply. The Plan promotes an extensive increase in hydropower, sufficient for both domestic use and for export, and expansion of biofuel and wind and solar energy.

5.2.5. One WASH national programme

The national One WASH programme operationalizes a memorandum of understanding and an implementation framework signed by the ministries of Water and Energy, Health, Education, Finance and Economic Development in November 2012 and March 2013, respectively. The programme is the Government's main instrument for achieving the goals of the GTP (52). It provides a framework for harmonizing Government and donor approaches to planning, procuring, implementing and financing and serves as a platform for closer partnership among planners, implementers, development partners and others to achieve common goals. The One WASH programme includes a "basket fund", the consolidated WASH account, which strengthens Government ownership and improves targeting of interventions. Within the One WASH programme, UNICEF supports the Government

of Ethiopia and the development community in setting up coordination and dialogue to improve efficiency and avoid duplication of efforts. UNICEF and partners support the secretariat of the water sector working group by acting as a platform for dialogue between the Government and development partners. UNICEF facilitates linkage of national achievements with international initiatives, such as "Sanitation and water for all". UNICEF also strengthens sector monitoring and evaluation through the national WASH Inventory.

5.2.6. National improved cooking stove programme

The programme is designed to contribute to implementation of the Government's plan to distribute improved cooking stoves by building a sustainable, vibrant market for the stoves and institutional capacity at all levels (53). A national steering committee comprises Government ministries such as the Ministry of Agriculture and Natural Resources and the Ministry of Water, Irrigation and Electricity and NGOs like the German Gesellschaft für Internationale Zusammenarbeit and the Netherlands Development Organisation. The coordinator of the programme is the Ministry of Environment, Forestry and Climate Change.

5.2.7. Health extension programme

The health extension programme comprises 16 service packages for delivering health care to rural populations; seven of the 16 packages address environmental health. This programme provides health education house to house to improve awareness, attitudes and knowledge about the consequences of environmental risks, on the understanding that "households produce their own health". Packages such as a healthy home environment include use of improved stoves, separating spaces for human and animals, cooking in a separate room, having windows in all rooms and having a chimney in the kitchen. "Smokeless improved stoves" are promoted mainly in rural communities in which biomass fuel is used for

cooking and lighting. Health posts deliver the packages to two female health extension workers, who provide the services to households. A “health development army” was introduced recently to increase the access of households to health benefits. The “army”, involving networking among one to five households, organizes the community and health workers on one platform to share best practices.

5.2.8. Housing programmes

Some of the policies and strategies issued by the Ministry of Urban Development and Housing are an urban housing supply policy and strategy, an integrated housing development programme, a rural housing strategy and a savings and financial planning strategy. There is massive demand for serviced, healthy, affordable housing owing to the current housing deficit and the poor quality of kebele housing stock. The various Government strategies and programmes promote healthy housing. Land and housing programmes in the country are summarized in Annex 6.

Social interventions

6.1 Maternal and child health and nutrition programmes

6.1.1. Health services for pregnant women

The pregnancy-related maternal mortality rate in Ethiopia is still high, with an estimated 412 deaths per 100 000 live births in 2016 (4); however, the number of maternal deaths is decreased steadily (from 891 in 2000 (26) to 412 in 2016 (4)) due to a comprehensive approach to pregnancy

and child care. Maternal health services, including antenatal care, vaccination, delivery and postnatal care, are provided for free in public health institutions to guarantee the well-being of mothers. Various contraceptive methods are also free of charge. These services have improved significantly, and they are monitored and evaluated periodically and annually. The total fertility rate tends to be above average in Somali Region (7.2) but is low in Addis Ababa (1.8).

↓ **Table 3.** *Indicators of maternal health, Ethiopia*

Indicator	2000 (26)	2005 (27)	2011 (28)	2016 (4)
Prevalence of contraceptive use among married women (%)	8.1	14.7	28.6	36
Total fertility rate (number per woman)	5.5	5.4	4.8	4.6
Antenatal care for pregnant women^a	27	28	34	62
Birth attended by skilled health staff (%)	5.6	5.7	10	26
Unmet need for family planning among married women (%)	35	33.5	25.3	35
Maternal mortality ratio (deaths per 100 000 live births)	891	673	676	412

^a Percentage of females of childbearing age who attended at least four antenatal visits (54).

Health posts staffed by health extension workers usually monitor pregnant women. Health service initiatives, such as basic emergency obstetric care, comprehensive emergency obstetric care, prevention of mother-to-child transmission of HIV and safe abortion, improve maternal health, with increasing access to skilled health staff

with the expansion of health facilities and public health initiatives. Mothers are encouraged to deliver in health facilities, which are equipped with ambulances and maternity rooms, to which pregnant women are admitted until delivery and for a few days after the birth to ensure the health of the mother and the baby. Relatives of

pregnant women are encouraged to stay with them to provide psychological and culturally acceptable support.

Clean household energy can be promoted to mothers during their contacts with health providers for antenatal care, delivery, postnatal care and vaccination. Health extension workers are strategic community partners in both maternal health and awareness of the importance of a safe, clean home.

6.1.2. Child vaccination

The mortality rate of children under 5 years in Ethiopia is one of the highest globally, although it is decreasing – from 166 per 1000 live births in 2000 (26) to 67 per 1000 live births in 2016 (4). Diarrhoea and acute respiratory illness are common causes of childhood death and disability. The national vaccination programme entitles every child to be vaccinated against 10 diseases: tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, *Haemophilus influenzae b* infection, hepatitis B, diarrhoea, pneumonia and measles. Every child is expected to complete the vaccinations at five contacts with providers. The rate of vaccination with all 10 vaccines has reached 39% among children aged 12–23 months, with differences by residence and region. The rate of vaccination of urban children and children in Tigray, Benshangul Gumuz and Amhara regions was above the national average in 2015 (1).

6.1.3. Nutrition programme

Malnutrition among children is still a public health problem in Ethiopia, with rates of 38% for chronic and 10% for acute malnutrition among children under 5 years (1). The Ministry of Health is implementing a national nutrition strategy to overcome child malnutrition, and the Ministry of Education has adopted a school health and nutrition programme, mainly for children at primary schools, which includes a school feeding programme, a school garden programme, school nutrition clubs and integrating nutrition into the regular curriculum. Needy schoolchildren are identified by the school community. The school feeding programme is supported by voluntary teachers, donors and communities; in future, it is expected that they will be replaced by public funding. Donors' support is channelled into a local NGO account established to run the school feeding programme in identified schools. One priority of the programme is girls from the least-served urban (slum) areas and rural communities in which there is a chronic shortage of food. The programme has difficulty in reaching the most destitute children among all those eligible to provide at least breakfast and lunch. In most of the schools selected for the nutrition intervention, mainly biomass fuel is used for cooking, and use of clean energy for cooking is not promoted. Schools could be used to increase the knowledge of both schoolchildren and the women from the local community who cook about use of clean energy. Both groups could act as agents of change by bringing messages about clean cooking to their homes and families.

6.2 Environmental health risk assessments


Three ministries are involved in environmental health risk assessment. The Ministry of Environment, Forestry and Climate Change has a mandate to request environmental impact assessments for eligible investments (Proclamation 299/2002). The report of the assessment must declare any possible effect on the immediate and the remote environment, interventions for mitigation and adaptation and

the monitoring system. The Ministry of Health evaluates the health risk of projects during investment and implementation and during epidemics. Site selection involving water, housing, villages, waste management, landfills and other investments are subject to health risk assessment. The Ministry of Housing and Urban Development is involved in the design of housing (urban and rural) that satisfies the health requirements for human

habitation. The design of housing is expected to include a separate kitchen with windows and to accommodate use of clean fuel sources for cooking. Collaboration among these three ministries in mitigating household air pollution

is vital to sustain the environment and health goals. The ministries have signed memoranda of understanding for the One WASH programme and for implementing the national environmental health strategy.



 Cooking injera with solid fuel
Credit: Jessica Lewis

Discussion

7.1 Barriers to adoption of clean household energy

Lack of coordination: Although Government policies on health, environment and energy (e.g. the energy policy and climate-resilient green economy) are conducive for the development of clean energy use, better coordination among sectors is required for implementation of policies. There is lack of coordination among the health and energy sectors, ministerial departments, regional and national agencies, the public and the private sector and national and international agencies. Coordination among ministries could be improved by ensuring better understanding of clean energy to make it a priority; for example, currently, the child and maternal health units in the Ministry of Health do not promote awareness of the health risks of household air pollution. Institutional arrangements are a barrier, as directorates are shared among three ministries (Ministry of Water, Irrigation and Electricity, Ministry of Environment, Forestry and Climate Change and Ministry of Mines, Petroleum and Natural Gas), and key institutions have overlapping mandates and insufficient technical staff and instrumentation to provide diversified energy sources at different levels. Moreover, involvement of the private sector is limited because of the lack of incentives and working capital.

Unaffordability: The high cost of a clean cooking stove is a major barrier, especially for poor rural households. Lack of cash is a major constraint. In rural areas, where the majority of the population lives, firewood is perceived as a “free” commodity, despite the time required to collect it. Changing such attitudes will take time and targeted incentives. Although electricity and ethanol are cheaper than charcoal and kerosene in some areas, inadequate infrastructure for their distribution still poses a barrier for use of these fuels for cooking in rural households. LPG is

affordable mainly to middle- and upper-income households (see Annex 1). In urban households, the initial cost of appliances is the main barrier to use of electricity for cooking, and the relatively poor efficiency of appliances (both the injera stove and the stove for other cooking) increases the cost to households.

Unclear regulatory responsibility: Regulatory (policy, licenses, quality, standards, etc.) and rural energy development activities relevant to household energy are not clearly designated as such. Institutional infrastructure, from federal to woreda level, would benefit from sustained capacity-building to improve planning, programming and implementation. Government stakeholder consultations showed that the responsibility for household energy is spread among many ministries, such as the Ministry of Water, Irrigation and Electricity (electricity, biogas, solar, technology development and promotion), the Ministry of Mines, Petroleum and Natural Gas (biofuel) and the Ministry of Environment, Forestry and Climate Change (national improved cooking stove programme). For example, weak links between the Ministry of Water, Irrigation and Electricity and the Ministry of Agriculture and Natural Resources has limited cooperation on promotion of biogas as a clean fuel. Such “siloe” responsibility and lack of coordination are barriers to designing a coherent strategy to reach Government policy goals, such as the targets for emission reductions in the climate-resilient green economy.

Lack of awareness: Households lack adequate information on the negative health outcomes associated with inefficient combustion of solid fuels, which has impeded the growth of market demand for clean cooking stoves. Households are

more concerned about the safety, convenience and durability of a new cooking device or fuel. Improving household awareness and adoption of clean energy will require clear messages and capacity-building.

Insufficient market development: The market has not developed sufficiently to support private sector enterprise. Entrepreneurship has not been encouraged, and there has been little return on investments in new ideas and technologies. There is almost no integration or interaction among the private sector, microfinance institutions and NGOs in the household energy sector. The availability of clean fuels is limited by poor market development, limited distribution networks and relatively small-scale production facilities. Small- and medium-sized enterprises working on clean cooking solutions have limited access to investment capital for their businesses, and they operate with low profit margins. Carbon finance schemes are not yet at the scale to support such enterprises; working capital is needed to bridge the gap.

Most energy companies in the private sector consider themselves importers of equipment or energy consultants, both requiring little capital investment. Outside of Addis Ababa, there is almost no capacity to market and install renewable energy systems, and, even in Addis Ababa, the status of solar and microhydro industries is pre-commercial and isolated from outside experience. There are limited financing modalities for investment or working capital for importing, manufacturing or distributing clean fuel technologies. The interest rate currently charged by commercial banks (7.5%) is the same for all businesses, and the high interest rate charged by microfinance Institutions (currently about 16%) discourages borrowing for investment in household appliances and income-generating opportunities.

Cultural factors: In many settings, women do not have income to purchase a new cooking stove and

rely on their husbands, who may be resistant to purchasing a new appliance, even if their wives are convinced of its benefits. Some exposure to household air pollution is associated with tradition, as charcoal is part of many cultural practices in food preparation. The coffee ceremony is a social tradition in which household members and neighbours talk and share opinions, and hosts gain social and economic support. The use of charcoal in making coffee for this ceremony is an integral part of social and cultural life. The ceremony usually lasts for hours, during which time participants are exposed to levels of particulate matter that exceed those of WHO guidelines.

Inadequate electricity supply: Many households in rural areas are in low-density settlements, and physical access is a major barrier to the provision of social and economic services to rural Ethiopians. The physical barriers isolate rural communities, reducing development potential. Ethiopia's highly dispersed settlements, with individual and family homesteads more prevalent than nuclear settlements or villages, raise the cost of electricity transmission, distribution, substations and control centres, which is a major logistical and financial constraint to its wider use as a clean fuel. In remote rural settings, lack of roads severely limits penetration of clean household energy, health care delivery and awareness-raising.

Frequent power cuts are a major problem in all areas of the country that are connected to electricity, and many households have back-up power supplies for lighting and cooking, with the use of diesel generators, car batteries, torches, solar lanterns and candles, depending on the household income. Recently, the Government launched a programme to rehabilitate distribution lines, particularly in Addis Ababa, and power disruptions have decreased from 18% to 13%.

7.2 Opportunities for increasing access to clean fuels

Leverage the model of the WASH programme: The One WASH programme is a successful precedent for interagency coordination in Ethiopia, providing a model framework for harmonizing Government and donor approaches to planning, procurement, implementation and financing and serving as a platform for the partnership. The programme operationalizes the agreement for implementation among the ministries of Water, Irrigation and Electricity and Energy, Health, Education, Finance and Economic Development and could serve as a model for a similar platform to coordinate the work of various ministries and development partners involved in household energy in Ethiopia. The One WASH programme fosters cooperation among ministries by integrating the flow of finance and its management, implementation and reporting into one system. Implementation of the national environmental health strategy and the integrated urban sanitation and hygiene strategy requires coordination of line ministries in a similar fashion. Government ministries are coordinated by steering and technical committees. The Ethiopian Planning Commission has shown interest in collaborating in such a framework for addressing household air pollution and clean household energy.

Leverage enabling environments in the health sector: Many enabling environments and work in the health sector address the health risks of household air pollution, including:

- the Health Policy and Health Sector Transformation Plan (public health with emphasis on mothers and children);
- health infrastructure for reaching rural areas in order to sustain health gains in households;
- access of every household to health extension programmes;
- the Environmental Health Directorate in the Ministry of Health and line offices in regional administrations;
- opportunities and platforms for promoting safe, clean homes, targeting children and mothers; and
- the national childhood vaccination programme to prevent major causes of death, including pneumonia.

Promotion of clean stove use in pregnancy programmes: Complications of pregnancy and childbirth are leading causes of maternal and infant deaths in Ethiopia. The rates of antenatal care and delivery in health facilities are currently low, and the health extension programme in primary health care units – comprising five health posts, one health centre and one primary hospital per district – is designed to provide clean, safe deliveries and to identify risk factors. The Ministry of Health recently introduced a delivery service with culturally acceptable practices and the social and psychological support necessary for mothers during delivery. Maternity rooms close to health facilities, constructed by donors, communities and the Government, are equipped with basic emergency obstetric and newborn equipment. Mothers stay at such centres after 37 weeks of pregnancy or when they have any symptom of labour. The support includes providing the coffee ceremony to families and of traditional foods to mothers. The maternity rooms at health facilities provide an opportunity to meet other pregnant mothers and family members to discuss clean cooking and heating and intensive health promotion. Posters, demonstrations and provision of clean and improved cooking stoves can be used. Community health posts, health centres and birth centres can also be used to promote use of clean energy.

Institutional stoves: Stoves are used in schools, hospitals, clinics, universities, refugee camps, military establishments and prisons, managed and operated mainly by the public sector. Stoves in schools, medical care facilities and universities directly introduce clean cooking to communities, accelerate adoption and dispel myths in the public perception. Currently, about 1 million customers are served meals cooked by local women in social institutions, of whom 60% are schoolchildren. Use of clean cooking in these kitchens introduces many local women to clean cooking.

Currently, the fuel and stoves used are similar to those in households, in which firewood is used on an open hearth to cook meals. The annual consumption of wood for cooking in schools, universities and detention centres is estimated to be 33 000 tonnes. There have been limited interventions to improve energy use for institutional cooking in Ethiopia, apart from improved biomass stoves for cooking and baking and use of electric boilers and hot plates, particularly in universities and hospitals. Lack of maintenance, ageing and the high replacement cost of electric stoves has meant, however, a tendency to move back to firewood. Electric stoves for injera baking have been widely used in institutions; however, most institutions now outsource the injera supply to commercial bakers, primarily for management. Financing opportunities such as grants for schools and commercial stove production business models for universities and prisons would be effective for scaling up stove production and reducing fuel consumption in social institutions in Ethiopia (55).

Regulations and standards: Recently, the renewable energy technology laboratory and workshop of the Ministry of Water, Irrigation and Electricity began to work with the Ethiopian Standards Authority to standardize and label cooking stoves. According to experts, indoor air pollution is not included in the standards; however, the Ministry may update its standards according to market development priorities. Government agencies such as the Ethiopian Standards Agency, Energy Authority and similar regional agencies should work together to protect consumers through regulation and quality control of imported stoves. Financing modalities should clearly be diversified, including long-term credit with subsidized interest rates, a revolving fund from the Government budget and support from partners, carbon financing and various subsidy schemes, to encourage the adoption of clean fuel technologies by low-income rural households.

Increase clean energy access in urban areas: In urban areas, even the poorest households pay for cooking fuel. Urban fuel markets are well established, as it is not possible to collect fuel, and clean fuels such as electricity now cost less than charcoal in many urban areas. Almost all households in large cities are connected to the national electricity grid, and use of electricity for lighting in these areas has reached almost 100%.

Elimination of kerosene subsidies has increased the retail price of kerosene in cities, and the price of wood tripled during the past decade (56). Hence, many households in large cities have exchanged their wood-burning injera stoves for electric stoves and cook on charcoal stoves rather than with wood or kerosene. Charcoal has, however, become one of the most expensive fuels. Increasing the efficiency of electric stoves could decrease fuel costs, and reducing the cost of appliances could encourage households to use 100% electricity for cooking. The Government should support standardization, certification, development and dissemination of induction stoves. In addition to pricing, penetration of electric stoves will require a reliable electricity supply, elimination of load shedding in residential areas and reliable transmission infrastructure and capacity. Promotion of light-emitting diode (LED) lighting and solar water-heaters could reduce urban electricity consumption, easing pressure on the electricity supply. There is a clear opportunity for concerted action to accelerate the transition to clean fuels. Slum upgrades in municipalities are a key opportunity.

The “integrated electrification road map” recently launched by the Ministry of Water, Irrigation and Electricity is an ambitious plan to connect all Ethiopian households by 2025 and will provide a good opportunity to scale up pilot programmes. Extension of the electricity grid in urban and periurban areas could provide an option for clean cooking, with associated price structuring to reach poorer households.

Reduce exposure to household air pollution in rural towns and villages: A transition to clean cooking technologies would reduce the adverse health effects of solid fuels and kerosene in Ethiopia, especially in rural areas. Providing incentives to increase the proportion of households in which batteries and solar photovoltaic panels are used for lighting would reduce kerosene use. In rural areas, solar lighting should be promoted, possibly in combination with higher tariffs for kerosene in order to eliminate kerosene use.

Although Ethiopia has had a consistently high rate of GDP growth over the past few years, efforts to reduce household air pollution are hampered by large wealth inequality. Rural populations are in the lowest wealth quintiles, and the affordability

of clean fuel is a significant barrier, especially in Afar and Somali regional states. This segment of the household energy market could also be connected to mini-solar grids, also for lighting. Road development will improve the distribution networks of clean household energy.

New financing mechanism for clean fuels and devices: Financial incentives for households could be improved and expanded through various channels. To reduce the cost of electric stoves for rural households, various financing mechanisms could be used, such as microfinance loan schemes, saving and credit cooperatives, installment payments, payment from traditional community savings and support structures, removing excise and value added taxes, payment through carbon trading mechanisms such as the Clean Development Mechanism and the Gold Standard, revolving funds and subsidy schemes. One way of promoting clean fuel use would be to integrate carbon financing into the development of housing programmes. Building houses that rely on clean energy (e.g. solar heating, electricity) is one of the initiatives in the Ethiopian climate-resilient green economy strategy to reduce greenhouse gas emissions. Households would have the incentive of covering part or all of the cost of appliances with carbon funds within this programme.

Promotion of biogas: The Government is responsible for disseminating biogas technology; however, the domestic market is limited to households with enough water and manure. Currently, the market is estimated to be 1.5–3.5 million households. The current technology is relatively expensive; there are no distribution channels for stoves and spare parts, and the private sector is not yet involved in the supply chain. To make biogas systems more affordable, households have an investment incentive of about 25% if they decide to invest in a biogas digester. Both the financial (e.g. saving time, reducing work load) and economic benefits of the digester (e.g. reduction in greenhouse gas emissions leading to carbon credits, increased agricultural productivity from the use of bio-slurry as fertilizer, deforestation avoided) are calculated to show the benefit of using biogas, thereby providing a solid argument for investment (57). Moreover, the programme facilitates credit from microfinance institutions and the Government's allocation budget as a revolving fund. In the current

programme, the Government in partnership with the Netherlands Development Organisation is the sole supplier of the technology; therefore, there is no competition among suppliers to provide alternative biogas technologies that might reduce the investment cost and ensure a wider variety of financial investment mechanisms. People living in areas in which there is an agricultural surplus, supported by the Agriculture Growth Programme, and in areas in which cash crops (e.g. coffee and sesame) are grown would be more likely to accept technologies such as biogas, solar energy, improved cooking stoves with chimneys and mini-solar grids; and farmers who have irrigation schemes have more disposable income and might be more inclined to take advantage of financing for clean household energy through traditional social institutions, such as iqubs, idirs and mahibers. Clean household energy could be integrated into existing programmes to leverage resources, e.g. promotion of clean fuel technology integrated with the Sustainable Land Management Project, health development and networking.

Promotion of ethanol: The draft national energy policy of Ethiopia (2013) identified ethanol as a renewable domestic fuel that could improve the security and reliability of the energy supply for transport and cooking. Ethanol is considered a viable clean fuel in the Ethiopian context because it is increasingly available at competitive prices. It is produced from sugarcane molasses, and annual production is expected to increase significantly in the coming years. Potential ethanol production from Government-owned sugar factories alone is estimated to be 350 million L annually – enough to meet the cooking energy requirements of 0.6 million households. The current market is only about 3000 households, which is far below the potential. More than 10 years have passed since ethanol was introduced as a cooking fuel in Ethiopia, but the market is essentially limited to a few households in Addis Ababa. Inadequate market development is due mainly to inadequate public awareness of clean fuel and cooking options, resulting constraints on availability, increased ethanol prices and limited distribution infrastructure and services. Particular problems are lack of a reliable source of ethanol and of a competitive local manufacturing market for ethanol stoves of acceptable quality. Apart from a large Government investment, carbon financing and promotion of private investment are necessary

to move to scale (58). Private sector companies should be encouraged to complete the value chain to maximize penetration of this technology.

Climate change considerations: The electricity supply in Ethiopia is based mainly based on hydrological power. Therefore, promotion of clean household energy could attract funding for market development at scale. Most of the actions for mitigating greenhouse gases proposed in the climate-resilient green economy strategy are related to energy, including reducing forest

degradation by use of energy-efficient stoves and renewable fuels. The target for clean cooking is the largest mitigation measure in the plan, constituting 20% of total greenhouse mitigation potential in 2030 (to 50 Mt CO₂ equivalent from 250 Mt CO₂ equivalent) (59). The demand for energy, particularly for electricity, is projected to accelerate in the next 10–20 years. Conservation will therefore be important in energy service provision in the future, in addition to increased generation capacity and extension of networks.

7.3 Recommendations to the health sector for accelerating the transition

Coordination with flagship programmes and initiatives: HAP should be addressed with a cross-cutting agenda for the Ministry of Health at all levels (federal, regional and district), with emphasis on its role as a risk factor for childhood pneumonia and chronic obstructive pulmonary disease in mothers. Integration of HAP with other health initiatives, such as WASH, HIV prevention and malaria, could leverage resources for the same target populations. The agricultural flagship programmes Productive Safety Net, Sustainable Land Management and Agricultural Growth cover the entire rural population of Ethiopia. Coordination with these flagship programmes will provide opportunities for awareness-raising and increasing adoption of clean cooking techniques.

Coordination with housing initiatives will offer opportunities for improving ventilation, kitchen design and use of clean energy. The Rural Housing Development Strategy, issued in November 2015 by the Ministry of Urban Development and Housing, emphasizes better rural housing design. The strategy includes regulation of the construction of residential units to include standards for kitchens and toilets in appropriate housing; improving the infrastructure of rural villages by providing roads, drinking-water, electricity and waste management to modernize the lifestyle of the rural population; establishing marketing, service and agro-processing centres in rural areas; guiding the development of rural

communities to improve livelihoods and health; and developing a strategic development plan. Environmental health is a consideration in the design principles.

Although the Government's rural housing strategy is not mandated, it offers an array of housing designs developed centrally by the Ministry to meet regional preferences, all of which address environmental health by recommending separate kitchens, placing kitchens and sanitation facilities downwind to avoid smells and exposure and a rainwater harvesting structure. Current housing designs do not account for air pollution from household energy use but provide a framework for a transition to clean fuels at scale through kitchen design, programming electrical connections in kitchens, leveraging housing initiatives to include financing and incentives for clean stoves and inclusion of separate kitchens with chimneys and ventilation where clean fuels are not available (and providing connections for where they are). Strategic planning to include clean household energy in designs could be done by a steering group consisting of representatives from the ministries of Water, Irrigation and Electricity, Health and Urban Development and Housing, to be formed through existing interministerial partnerships. The aim of the strategy would be to include standards for kitchens in approved designs for the construction of residential units. Communities in which cooking is done indoors

should be the priority for introducing clean household energy, as exposure during cooking outdoors is substantially lower.

Coordination with informal social and community groups: Government agencies and the health sector could work with local and regional institutions to increase awareness of clean energy options and their benefits and to identify distribution channels through social networks. For example, idirs are local institutions established by a group of people united by ties of family, friendship, neighbourhood or job that provide self-help, mutual aid and other social activities (60). Some idirs specifically involve teachers, women or ethnic or clan groups, but they are democratic and egalitarian, open to anyone, regardless of their religion, sex or ethnic affiliation (61). Members regularly contribute money to be used for emergencies and to cover the costs of burial (62). Idirs assist their members in situations such as loss of assets by theft or fire, death of livestock or health problems (63) and support members in availing themselves of any opportunity they consider could benefit them. Idirs offer an opportunity for promoting clean fuel and disseminating technology.

The mahiberes or senbetes are voluntary community associations of Orthodox Church followers. Mahiberes help members to cope with risk (e.g. providing financial support, such as interest-free loans, to members in time of need), receive information and resolve conflicts. In mahiberes, people discuss issues of common interest, share information and coordinate activities in a form of social media for the community. This kind of social platform can be used as an opportunity to promote the benefits of using clean fuels and disseminate clean fuel technologies to the community. Iqubs are informal institutions that lend money to members without requiring collateral or interest. They pool money from individual members and give it back in a lottery system. Iqubs give credit in the same way as banks but on the basis of social qualification rather than income or assets (64) and are similar to revolving funds. Women use this social institution to buy modern furniture and household equipment, which is sometimes used as loan guarantee. Use of this system is an opportunity for promoting use of clean fuel.

Coordination with farmers' training centres:

Farmers training centres link farmers with technologies that can improve their livelihoods. About 18 000 training centres are established throughout the country (65). They have been used to increase the reach and effectiveness of extension services, ranging from capacity-building in use of farming technologies and providing market information, communication and advisory services. The centres also link farmers with institutional support services such as input supply, credit and market services. They help women in using technologies that reduce their work load and improve their lives. Farmers training centres are staffed with experts in crops, livestock, fisheries and natural resources to support farmers in all aspects of agriculture (66). These centres could serve as demonstration sites for clean cooking technology to create awareness of the benefits of clean fuel and as links to local financial institutions, such as rural savings and credit cooperatives and microfinance institutions.

Raise awareness and advocate for the health benefits of clean fuel:

The population has limited knowledge of the health impacts of household air pollution. Concerted marketing and awareness programmes to dispel myths about clean fuels are important priorities for increasing market penetration (e.g. taste trials, safety). Primary health care units could be used to mobilize health and local leaders to increase awareness of the health benefits of clean fuel through brochures, leaflets and conversations. Tools that are culturally acceptable to mothers and elders should be designed. Once demand is created, sanitation marketing in woreda could include promotion of improved stoves and solar technology for communities. The One WASH programme integrates and harmonizes resources on WASH, and stakeholders use one system for planning, financing, implementing and reporting to mitigate the risks associated with unsafe water, sanitation and personal hygiene. The health benefits of WASH would be maximized if clean fuel were included, as it targets the same population. Other household initiatives, such as distribution of bednets and HIV prevention, could also be used to increase awareness about clean household energy. WASH, HIV and malaria programmes provide models for successful coordination of priorities at national level and across sub-Saharan Africa.

Conclusions

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

8.1 Convening and coordination

The adoption of clean household energy requires prioritization and intervention by the Government in an integrated framework to coordinate the work of different stakeholders and interministerial partnerships. The Ministry of Health could convene an interministerial technical group, hosted by the Federal Planning Commission, to prepare an evidence-based strategic plan for increasing penetration of clean household energy. The plan should include market development, finance, coordination of existing initiatives and a road map for solutions appropriately tailored to different regions and urban and rural contexts (including considerations such as house design, ventilation, kitchen placement, clean fuels for cooking, heating and lighting). An early step would be to identify and designate the roles of Government agencies, NGOs, microfinance organizations and the private sector in developing and implementing programmes to promote clean cooking stoves and other clean energy solutions.

The Ministry of Water, Irrigation and Electricity could coordinate clean household energy programmes with planned and ongoing initiatives for electrification. The priorities should be investment in extending the existing distribution networks to customers at the “bottom of the pyramid” and designing financial mechanisms with financial institutions to support producers, distributors and users of clean cooking stoves. Partnerships with the private sector could be pursued to bring clean cooking initiatives to scale, while policy, legal and regulatory reforms could be undertaken to improve the business climate for clean household energy. Consumer analyses could be conducted to determine the factors that influence household choices of cooking technologies and improve data collection, analysis and knowledge management to establish the feasibility and market potential of different clean fuel applications.

8.2 Assessment, monitoring and evaluation

Household energy policy scenarios and health impact assessments are required. Capacity for surveillance of disease, injuries and incidents

should be assessed. It would be useful to identify a peri-urban demonstration project for use of clean fuel and to evaluate its potential scale-up.

8.3 Communication and education

The interministerial steering group could coordinate the work of all stakeholders and avoid

mixed messages from different vested interests. International consensus on priorities, as has been

done for malaria, WASH and HIV, would channel regional priorities. Capacity for the use of clean household energy has multidimensional aspects (e.g. with respect to gender roles, environmental issues, income generation, education and health). Messages should emphasize the multiple benefits of clean household energy, including for livelihoods, ecology and the environment. The Ministry could also coordinate communication and education campaigns to raise public awareness of the benefits of clean household energy and the risks of burning solid fuels (including garbage) and kerosene.

The Ministry of Health might review and update the training curriculum for health extension workers to include rapid training in the health effects and prevention of HAP.

In cooperation with the Ethiopian Standards Agency, the Ministry of Water, Irrigation and Electricity could enhance the capacity of the national workshop and testing laboratory for setting standards, testing, certification, quality control, warranties and labelling of clean cooking stoves and conduct training to improve technical and management capacity.

8.4 Policy advocacy

Policy and advocacy measures could include integration of WHO recommendations into national standards; evaluation and promotion of laws, policies and regulations for access to and safe use of clean fuels to protect health,

including a review of the electricity tariff system; and integration of clean household energy into projects for upgrading slums. Advocacy should be evaluated for effectiveness.



People sell and buy charcoal on an outdoor market in Ethiopia
Credit: John Wollwerth / Shutterstock

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Annex 1. Additional data on energy sources in Ethiopia

↓ **Table A1.1.** *Energy sources in Ethiopia*

	Coal	Crude oil	Oil products	Natural gas	Nuclear energy	Hydro-energy	Geothermal, solar, other	Biofuels and waste	Electricity	Total
Production	0	0	0	0	0	0.832	0.065	45.813	0	46.710
Imports	0.253	0	3.472	0	0	0	0	0	0	37.25
Exports	0	0	0	0	0	0	0	0	-0.014	-0.014
Stock changes and international bunkers	0	0	0.006	0	0	0	0	0	0	0.006
	0	0	-0.438	0	0	0	0	0	0	-438
Total energy supply	0.253	0	3.041	0	0	0.832	0.065	45.813	-0.14	49.900
Transfers	0	0	0	0	0	0	0	0	0	0
Statistical differences	0	0	-5	0	0	0	0	0	0.011	0.006
Electricity plants	0	0	-1	0	0	-0.832	-0.065	0	0.898	0
Oil refineries	0	0	0	0	0	0	0	0	0	0
Energy industry own use	0	0	0	0	0	0	0	0	-0.027	-0.027
Losses and other transformation	0	0	0	0	0	0	0	-8.927	-0.152	-9.079
Total final consumption	0.253	0	3.035	0	0	0	0	36.886	0.716	40.890
Industry	0.253	0	0.737	0	0	0	0	0	0.241	1.231
Transport	0	0	1.612	0	0	0	0	0.006	0	1.618
Other	0	0	0.594	0	0	0	0	36.880	0.474	37.948
Residential	0	0	0.281	0	0	0	0	36.527	0.277	37.085
Commercial and public services	0	0	0.055	0	0	0	0	0.353	0.192	0.600
Agriculture, forestry and fishing	0	0	0.129	0	0	0	0	0	0	0.129
Not specified	0	0	0.129	0	0	0	0	0	0	0.134
Non-energy use	0	0	0.092	0	0	0	0	0	0	0.092

In thousand tonnes of oil equivalent (MToe) on a net calorific value basis. "Other" includes residential, commercial and public services, agriculture, forestry, fishing and unspecified (1).

↓ **Table A1.2.** *Relative cost of cooking fuels on the basis of useful energy (October 2014 prices), Addis Ababa*

Fuel type	Firewood	Charcoal	Kerosene	LPG	Electricity	Ethanol
	kg	kg	L	kg	kWh	L
Price (ETB/unit)	1	8.7	16	43.8	0.567	13.99
Energy content (MJ/unit)	15	29	35.3	45.2	3.6	24
Price of stove (ETB/unit)	0	70	90	460	450	1035
Life of stove (years)	0	4	5	10	10	10
Thermal efficiency of stove (%)	10	25	42	55	60	60
Annualized capital cost (CFR @ 10%)	–	22.1	23.7	73.2	73.2	168.4
Fuel cost (ETB/year)	1740	3152	2816	4598	685	2535
Total expenditure per year (ETB)	1740	3154	2840	4671	758	2704
Total expenditure per month (ETB)	145	263	237	389	63	225
Index (firewood = 1)	1.00	1.81	1.63	2.68	0.43	1.55
Rank	2	5	4	6	1	3

Source: reference 54.

LPG, light petroleum gas; ETB, Ethiopian birr; CFR, capital financing requirement.

Household energy fuels and technologies used in Ethiopia

Firewood

Firewood is the main cooking fuel used in rural households, and many households also use wood for lighting and space heating. Logging and consumption of wood is the second main driver of forest degradation in Ethiopia. Emissions from burning wood are expected to increase from about 25 Mt CO₂ equivalent in 2010 to more than 40 Mt in 2030 as a result of unsustainable use as fuel. The United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation is one of the four priority programmes in the climate-resilient green economy, because forests account for one third

of national greenhouse gas emissions, and less deforestation and less forest degradation offer huge potential for abatement. Ethiopia has the second-largest afforestation and reforestation programme in the world.

Because of deforestation, access to biomass fuels has decreased significantly throughout the country and drastically in some parts. Reduced access to wood biomass usually has greater development and social effects on women and young people. For instance, when more time is required to collect wood, there is less time for productive activities such as family care, leisure, education and income-generation. “Energy poverty” therefore affects women and children disproportionately.

Stove types

Three-stone open-fire stoves and traditional charcoal stoves are still common in many rural households. The penetration of improved biomass cooking stoves increased significantly, however, during planning of the GTP I (2010–2015), and, by 2015, 8.875 million biomass stoves had been distributed (1). An additional 1.6 million stoves have since been distributed.¹

Some of the leading models are the Mirt (Fig. A1.1) and the Gonzie for baking injera (traditional Ethiopian bread). The Tikikil (Fig. A1.1) wood

stove, used for general cooking, is gradually being accepted. Use of enclosed clay stoves is universal in Tigray Regional State. Laboratory tests indicate that the Mirt and Tikikil stoves can reduce fuel use by 50% from that with the three-stone open fire (2); however, the gain may be slightly less in practice: in a study conducted in the field, the fuel saved with a Mirt was 22–31% of that with a three-stone fire (3).

Cooking stoves with chimneys that discharge smoke through the walls are common in some parts of northern Ethiopia. As they are made locally, their cleanness and efficiency are unknown.

A



B



↑ **Fig. A1.1.** Women in Ethiopia using a Mirt stove (A) and a Tikikil stove (B)

Source: Energypedia, GIZ Endalkachew G/Silassie.

Source: Energizing Development (EnDev) Ethiopia, 2014.

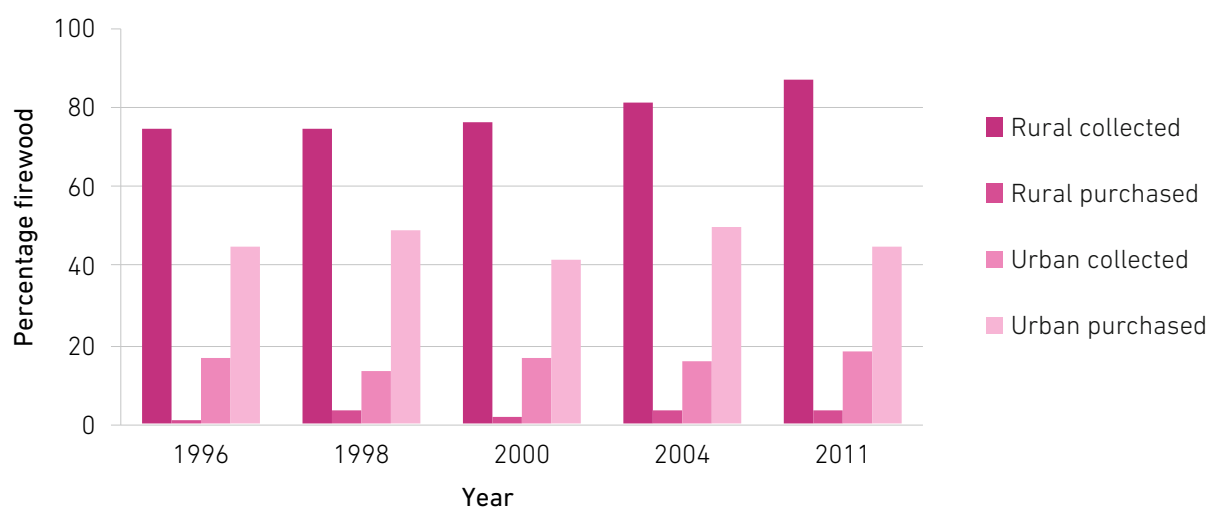
Market structure and firewood gathering

Firewood is usually collected and transported by households in rural areas, and very little is purchased (Fig. A1.2); there are essentially no intermediaries. In urban areas, most firewood

used for cooking is purchased from collectors supplied from the periphery of cities.

Firewood cannot be collected in Government forests or private homesteads and may be collected from communal forests only by members. There is no legal restriction on the use of firewood in urban areas; however, the new condominiums and other buildings do not have kitchens in which firewood can be used.

¹ Personal communication from the Ministry of Water, Irrigation and Energy.



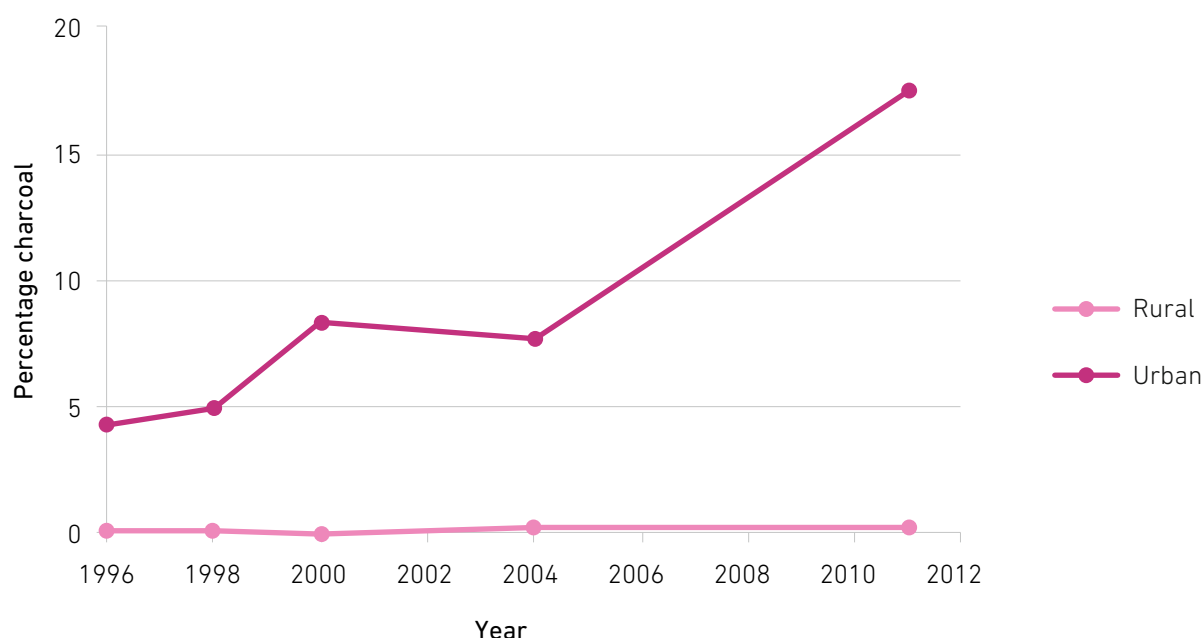
↑ **Fig. A1.2.** Proportion of firewood in the total cooking fuel mix by source

Source: reference 4.

Charcoal

National charcoal consumption is estimated to be 500 000 T/year. Most (> 90%) is used in rural areas; however, it is used as a primary

or secondary cooking fuel in almost all urban households, regardless of income. The proportion of charcoal in the household energy mix in urban areas increased markedly during the past two decades (Fig. A1.3), and it is currently the main cooking fuel in 30% of households (5).



↑ **Fig. A1.3.** Proportion of charcoal used for household cooking

Source: reference 4.

Charcoal and charcoal fuels represent a substantial market: charcoal for use as a cooking fuel has an annual market of about 100 million €, and the annual market for charcoal stoves (both traditional

and improved) is estimated to be 400 000 €. Much of the charcoal used in major cities in the northeastern Rift Valley and Addis Ababa is produced from *Prosopis juliflora* in Afar Regional

State. *Prosopis* has become an invasive bush species, which is encroaching into much of the eastern Rift Valley and reducing the biodiversity of the region. Hence, charcoaling is informally prescribed as a management strategy.

Stove types

The Lakech and Mircha stoves are among the most widely used improved charcoal stoves in Ethiopia.

Market structure

Charcoal production and marketing have always been almost entirely informally organized by the private sector. Before 1993, the State-owned Construction and Fuelwood Production and Marketing Enterprise had a monopoly on charcoal production and marketing. In practice, however, a large proportion of charcoal was produced and marketed outside the State monopoly. After 1993, the Enterprise was disbanded. It was envisaged that charcoal producers would be licensed and that bureaus of agriculture would develop and enforce sustainable forest practices; however, legislation to stop charcoal production and marketing has failed, as it is not enforced and it continues to be legally ill-defined. The absence of commercial charcoal production means that the techniques used to make it remain undeveloped. With an average conversion efficiency of about 16%, techniques currently used in charcoal production are inefficient. Charcoal is produced by thousands

of local farmers in open pits, which represents a major cash income for many rural households (6).

The Government's energy policy does not encourage use of charcoal as a major cooking fuel; however, the demonstrated demand and preference for charcoal of urban consumers appears to have persuaded the Government to be more lenient. Little or no official technical support is given to charcoal production and marketing, as the official view is that charcoal production is responsible for deforestation. Charcoal production is also limited simply because there is insufficient wood to meet the demand. The shortage of charcoal is driving the price higher, which may result in decreased consumption in the foreseeable future.

Dung

Significant quantities of animal dung are used as fuel in rural households, particularly in the highlands in northern Ethiopia, in Tigray, Amhara (around lake Tana and North Shoa), eastern Ethiopia (eastern Oromia) and Southern Ethiopia (the southern Rift Valley in Southern Nations, Nationalities and Peoples Region). About 7% of the national population but less than 2% of the urban population uses dung for cooking. Fresh dung must be dried before it can be used as fuel (Fig. A1.4). During drying, it is either left in its natural shape or is formed into flat cakes and mixed with agricultural residues to enhance burning by increasing energy density.

Use of dung as fuel limits other use as an agricultural soil supplement.



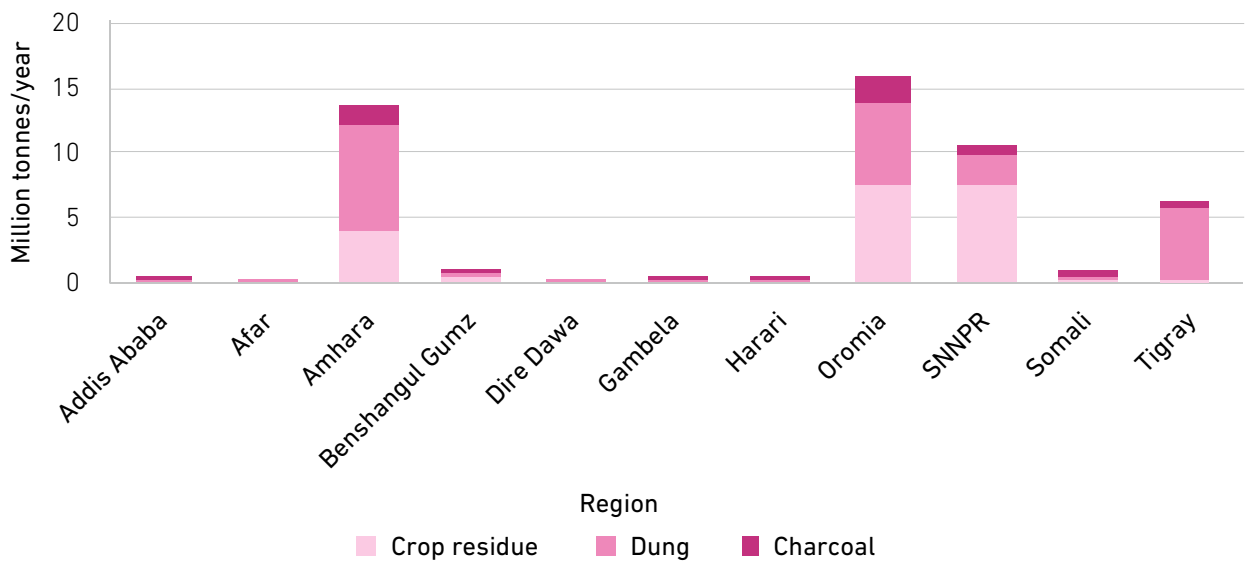
↑ **Fig. A1.4.** *Dung being dried for use as fuel*
Source: SNV Ethiopia, 2010.

Market structure

Dung still has a market in many towns in the northern highlands and in some central and eastern towns. It is transported mainly by donkeys or women; hence, the supply is exclusively from farmers living close to towns. As it is difficult to dry dung patties in the rainy season, this fuel is used mainly in the dry seasons.

Crop residues

Crop residues are used as fuel almost exclusively in the highlands, although relatively little is used in Tigray (Fig. A1.5). Crop residues are usually used with wood or cow dung to enhance burning by increasing energy density.



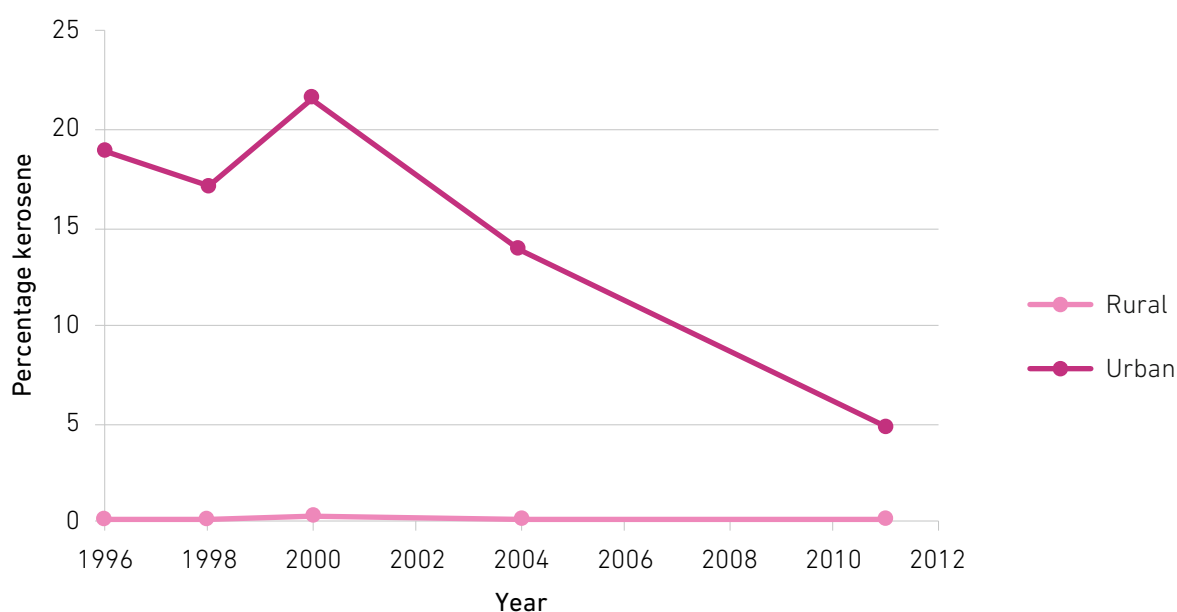
↑ **Fig. A1.5.** *Crop residue, dung and charcoal use by region*
Source: reference 7.

Stove types

There are no special stoves for burning crop residue; however, as it is used mainly in rural households, three-stone stoves are the most common.

Kerosene

Kerosene is used for cooking mainly in urban areas and is used for lighting exclusively in rural Ethiopia. The proportion of kerosene in the national energy mix used for cooking is less than 1%. In urban areas, use of kerosene for cooking has decreased sharply, from 21.5% in 2000 to 4.9% in 2011 (6) (Fig. A1.6).

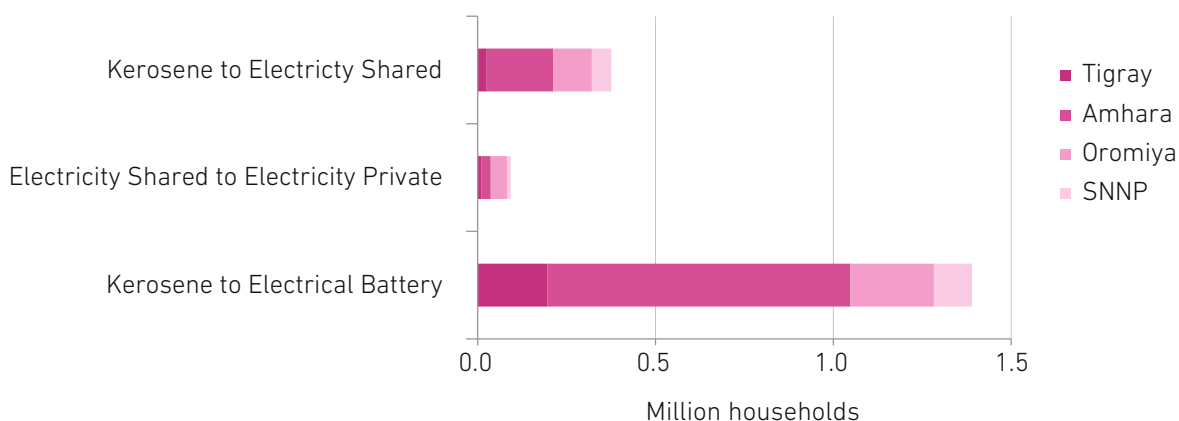


↑ **Fig. A1.6.** Proportion of kerosene used as cooking fuel in the household energy mix

Source: reference 4.

Rural households that participated in a recent survey of the lighting market reported that they used kerosene on average 3 h/day (8). Between 2006 and 2011, 1.86 million households changed from kerosene to electricity or electrical batteries

(1.45 million to batteries and 0.41 million to electricity). The four largest regions (Amhara, Oromia, Southern Nations, Nationalities and Peoples and Tigray) accounted for 95% of the change from kerosene (Fig. A1.7) (4).



↑ **Fig. A1.7.** Switch of fuel used for lighting, 2011 versus 2006

Source: reference 4.

SNNPR, Southern Nations, Nationalities and People's Region

Market structure

Kerosene is an imported fuel regulated by the Ministry of Petroleum and Natural Gas. It is transported and distributed by companies that import and distribute diesel and gasoline fuel with those fuels and is distributed at service stations by several international and local wholesale and retail distributors. The companies have large depots within the country.

Kerosene imports are not sufficient to meet market demand. Unlike other petroleum fuels, such as petrol, diesel and LPG, kerosene is not subject to excise and value added taxes (8). Its cost has nevertheless increased substantially because of removal of the subsidy and price determination according to the world market, like other petroleum fuels, although it is still exempt from excise and value added taxes. Its poorer affordability has suppressed demand in recent years. Consumption and expenditure for kerosene are shown in Table A1.3.

↓ **Table A1.3.** *Kerosene consumption and expenditure*

	Total	Amhara	Oromia	SNNP	Tigray
Consumption (L/month)	1.9	2	2.2	1.5	1.8
Price (ETB/L)	19.8	19.5	19	21.4	20.4
Expenditure on kerosene for lighting ETB/month	37.8	38.5	41.1	32.9	36
Proportion of total household expenditure (%)	3.6	3.8	3.9	2.4	3.6

Source: reference 8.

SNNPR, Southern Nations, Nationalities and Peoples Region; ETB, Ethiopian birrs

Liquid petroleum gas (LPG)

Less than 1% of the national population reported that they used LPG as their primary cooking fuel (5). Consumption of LPG by households for cooking and boiling water is limited mainly to Addis Ababa. LPG stoves cannot be used for baking injera. City households appreciate the fast cooking that is possible with LPG; however, affordability is a major barrier for adoption by many households. Perceptions of the risk of explosions also limit wider adoption.

unaffordable for populations with low incomes, and, as it is imported, use of foreign currency must compete with other national priorities, leading to a fluctuating supply. LPG requires appropriate infrastructure for storage, transport, bottling and distribution, representing a sizeable investment. Currently, only the major oil distribution companies supply the market in Ethiopia.

Market structure

There is no regulatory or institutional framework for LPG; however, importers and distributors promote its use. As taxes are levied on LPG, it is

Electricity

Urban and rural areas have a large gap in access to electricity. Most large urban areas have almost complete electricity coverage: 95% of households in cities and 83% of those in small towns. In truly rural areas (i.e. excluding small towns), however, only 9% of households have access to electricity (Table A1.4) (9).

↓ **Table A1.4.** Rates of access to electricity in urban and rural Ethiopia by type of connection, 2013

Region	Total (%)			Government (%)			Shared (%)		
	Rural	Small town	Large town	Rural	Small town	Large town	Rural	Small town	Large town
Tigray	13	93	88	6	52	31	8	41	56
Afar	18	100	100	6	62	8	11	38	92
Amhara	9	95	92	3	32	32	6	62	60
Oromia	8	81	97	3	45	32	5	35	65
Somali	3	60	69	1	9	15	1	51	55
Benishangul-Gumuz	10	67	0	4	42	NA	6	25	NA
SNNPR	10	76	98	3	35	29	7	40	69
Gambella	4	91	100	0	73	13	3	18	87
Harari	67	NA	100	25	0	65	43	NA	35
Addis Ababa	NA	NA	95	NA	NA	60	NA	NA	36
Dire Dawa	24	0	100	3	NA	52	21	0	48
Total	9	83	95	3	39	39	6	44	55

Sources: references 9 and 10.

NA, not available; SNNPR, Southern Nations, Nationalities and Peoples Region

The proportion of households with access to electricity is increasing due to extension of the national grid and increasing numbers of stand-alone systems and mini-grids, from 13% of the population in 2000, to 22% in 2010, 24% in 2012, 27% in 2014 (11) and 30% in 2017, according to the Ministry of Water, Irrigation and Electricity.

Unfortunately, interruptions of electric power in grid-connected urban areas are frequent, and the reliability of the power supply (uninterrupted, consistent electricity) for domestic customers appears to have worsened over the past 5 years. In 2011, more than 85% of households reported having had a power interruption at least once in the previous week, and more than 50% reported having had three or more interruptions (12). The frequency and length of power blackouts have increased not only because of supply shortages (generation and transmission capacity shortfalls) but also because of limited distribution infrastructure to meet the rapidly increasing connections and demand.

Another problem is that many domestic customers receive lower-than-standard voltage ($220\text{ V} \pm 10\%$). In 2014, electricity blackouts amounted to an estimated 600 h/year (7% of the year), and sales lost due to electrical outages was estimated at 5% (13). In 2010, about 8 TWh or 18% of electricity was lost through transmission and distribution, and the current estimate is 13%.²

Market structure

Ethiopia has the lowest electricity tariff in Africa, as it is a regulated monopoly market. The current tariff structure and service for household use (Table A1.5) increase with the rise in kWh consumption, providing an incentive for poorer households and discouraging overconsumption by more affluent groups (14).

2 Personal communication from the Director of Alternative Energy Development and Promotion, Ministry of Water, Irrigation and Electricity.

↓ **Table A1.5.** *Domestic electric tariff, interconnected system*

Block	Monthly consumption (kWh)	Rate (ETB/US\$)
1st	0–50	0.273/0.01
2nd	51–100	0.3564/0.013
3rd	101–200	0.4993/0.018
4th	201–300	0.5500/0.02
5th	301–400	0.5666/0.021
6th	401–500	0.5880/0.0216
7th	> 500	0.6943/0.0255

ETB, Ethiopian birrs.

With a few exceptions in modern houses, the distribution lines and transformer network in Ethiopia are not yet ready to provide enough electricity for cooking. It takes a long time to establish an electricity connection in a new household (obtaining a meter, upgrading transformers to extend power distribution to neighbourhoods with new buildings and to newly developed sites), for many technical and bureaucratic reasons. Substantial numbers of households are waiting for electricity in their new homes in large cities around the country. An Ethiopian Electric Utility technician reported that the reasons for the delay include technical verification of requests, insufficient materials in stock and insufficient technicians. The demand for electricity, particularly for lighting, is increasing in many Ethiopian households and has risen sharply in many large cities with the increasing number of modern houses being constructed within the Government's housing programme, housing for private individuals and cooperative housing.

Ethiopia has ambitious plans to extend access to electricity and to invest in hydropower, such as construction of the largest hydroelectric power dam on the Blue Nile River (with a maximum planned installed capacity of 6000 MW). Because of the emphasis on hydropower and on wind and geothermal energy projects, less progress has been made in the use of other sources of renewable energy, such as ethanol, biogas and the Sun.

Solar energy

Solar energy is used in rural buildings that are not connected to the grid, including homes and telecommunication and social services (such as water pumping, health services and schools). There are also a few thousand solar water-heating installations in Addis Ababa and a few other major cities.

The solar home lighting market today is essentially for solar lanterns and solar home systems, although other models are being pilot-tested, including mini-grids, solar kiosks and solar charging stations, with 2.032 million solar technologies – mainly solar lanterns – distributed (1). According to the Ministry of Water, Irrigation and Electricity, over 40 000 solar home systems for lighting have been installed from the Rural Electrification Fund.

Quality control of solar products has been a significant issue in Ethiopian markets, with up to 60% poor or substandard products. A number of initiatives, including improved standards for and assembling of products, have been initiated to address this issue (15–17).

Biogas

Biogas is used for cooking and lighting and as an organic fertilizer on farms. Biogas is generally used for daily cooking and boiling water but not for baking injera. This limits its potential use as clean household energy fuel, as households will use firewood for this essential task. Domestic biodigesters provide clean energy for households

that have sufficient cattle and water (Fig. A1.8) and also co-benefits, such as better agricultural productivity from application of bio-slurry as a fertilizer, less deforestation, mitigation of climate

change, a reduced workload and time saved by avoiding firewood collection. A potential 1.1–3.5 million households are projected to use biogas energy in Ethiopia (18).



↑ **Fig. A1.8.** *Biogas digester and its use for lighting and cooking*

Source: Heather Adair-Rohani.

The biogas sector in Ethiopia started with the launch of the first phase of the national domestic biogas programme in 2008, which led to the distribution of 17 869 bio-digesters.³ With substantial funding from the European Union, the programme plans to construct 30 000 bio-digesters during the second phase up to 2021. The programme operates on a cost-sharing basis with households, donors, regional governments and the Federal Government, the contributions of the public sector being used to run the programme and as an investment incentive for households to compensate for “free” firewood.

Lack of water in many areas limits the applicability of biogas technology and is a barrier to dissemination in pastoral and semipastoral areas of Ethiopia, where the cattle population is very high. Lack of after-sales services and spare parts are major problems. The current technology is a fixed dome bio-digester that can be built only by a trained mason.

promotion. The financing mechanisms and the technical capacity to reach all households are thus limited. The market is restricted to households with enough water and manure for daily input. The affordability of the current technology is the major constraint to its promotion. To increase penetration, awareness must be raised at national level, the market must be catalysed, financing mechanisms must be found, and technical capacity in design and installation should be enhanced.

At Federal level, the programme is led by the National Biogas Programme Coordination Office, hosted by the Ministry of Water, Irrigation and Electricity. The steering committee includes staff from the ministries of Agriculture and Natural Resources, Finance and Economic Development and Environment, Forestry, and Climate Change, as well as representatives of the private sector and NGOs.

Ethanol

Ethanol is used for cooking and lighting in Ethiopia; however, its use is limited because of the high initial cost of the stoves and the limited, unreliable supply of fuel. The stoves are not manufactured locally and may be unaffordable

Market structure

The market for biogas is not yet well established or mature. Currently, a project approach is being used, with funding of specific duration and intensive

³ From the Ministry of Water, Irrigation and Electricity Biogas Programme Office.

for many prospective users. As the fuel is not yet widely used, the distribution system and services are not developed. Another limitation is that current stove technology does not allow baking of injera, for which households would continue to use wood.

Ethanol is a recent addition to the Ethiopian energy mix. In 2017, it contributed 0.4 TWh annually, and 10 500 ethanol stoves have been distributed for household use over the past decade by Gaia Association-Ethiopia. Of these, 7500 are in refugee camps and 3000 in households in Addis Ababa.

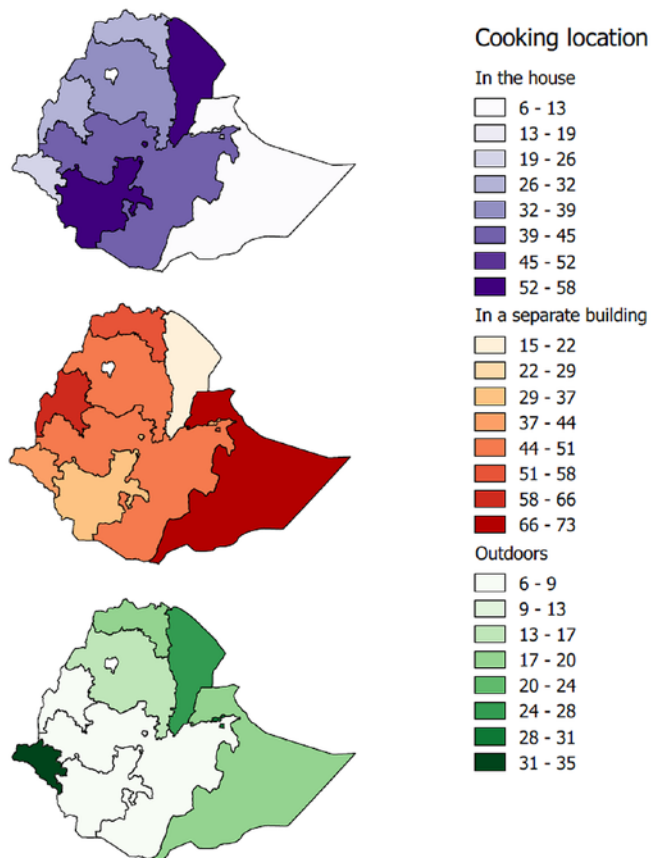
Energy for ethanol production is generated during sugar production. It is currently produced on six sugar estates, with a planned increase to 12 estates by 2020, where sugarcane is converted into sugar and the remaining sugar molasses into ethanol. Ethanol is used as a gasoline additive and also in cooking stoves in the Gaia Project, with projected supply for 200 000 stoves when all the sugar factories are operational.

Market structure

The potential market is estimated at 0.6 million households (19). The challenges are lack of a reliable supply, an inadequate distribution system and services, the high cost of imported ethanol stoves and inadequate public awareness. The Ethiopian Government energy policy includes biofuel as part of household energy.

Site at which cooking is done in Ethiopian households

Solid fuel is used for cooking in 93% of households in Ethiopia, virtually all of which is wood. Exposure to smoke from cooking is higher when cooking is done inside a house rather than in a separate building or outdoors. Fig. A1.9 shows the areas of the country in which most households cook inside the house, mostly in Afar and Southern Nations, Nationalities and People's regions, followed by Oromia and Amhara. Regions in which more than 75% of the population cooks inside could be an immediate priority for targeting with clean fuel initiatives.

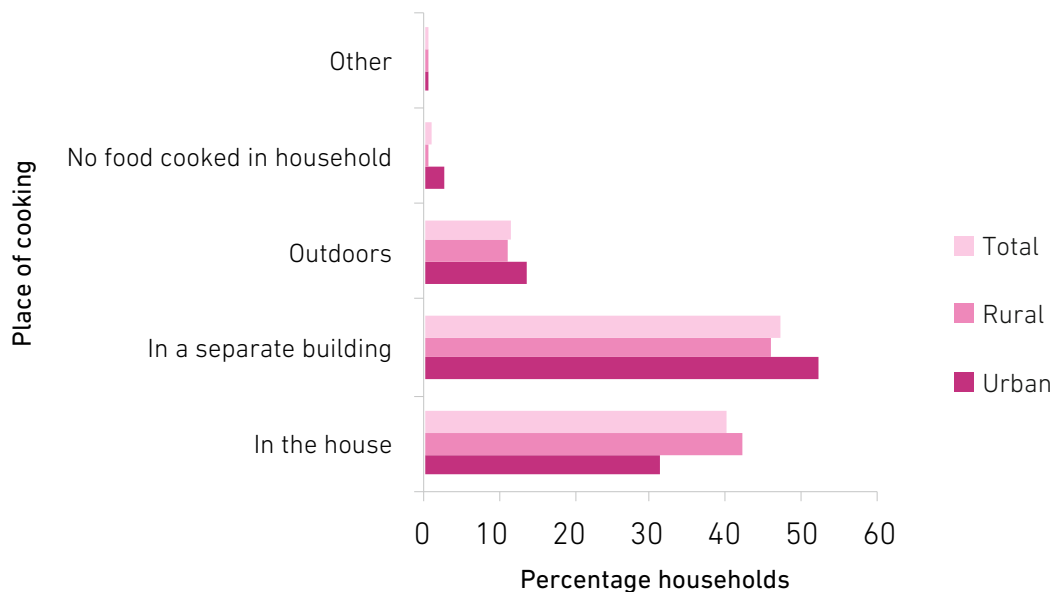


↑ **Fig. A1.9.** Areas of Ethiopia in which cooking is done inside houses

Source: reference 20.

Cooking is done in a separate building in 47% of households (Fig. A1.10), and the proportion has increased since the 2011 demographic and health

survey (36%) (21). Someone smoked inside the house daily in 6% of households.



↑ **Fig. A1.10.** Place in which cooking is done in Ethiopian households

Source: reference 6.

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Annex 2. Air pollutants in households in selected urban and rural areas of Ethiopia

Reference	Study design	Setting	Sample size	Household air pollution indicators			
				PM _{2.5} (µg/m ³)	CO (ppm)	PM (µg/m ³)	NO ₂ (µg/m ³)
1	Cross-sectional (monitoring of indoor air pollution) (Berkeley UCB particle monitor)	Addis Ababa, disadvantaged homes	9 with kerosene and charcoal stoves	Before use of clean stove: 48-h median: 330 After use of clean stove: 140	Before use of clean stove: 48-h median: 25.1 After use of clean stove: 4.5		
2	Cross-sectional (monitoring of indoor air pollution) (Berkeley UCB particle monitor)	Kebribeyah refugee camp	11 houses with wood and charcoal stoves	Before use of clean stove: 48-h median: 2 190 After use of clean stove: 110	Before use of clean stove: 48-h median: 54 After use of clean stove: 15.9		
3	Cross-sectional (monitoring of indoor air pollution)	Bonga refugee camp	11 houses with traditional three-stone and modified wood stoves	Before use of clean stove: 48-h median: 560 After use of clean stove: 100	Before use of clean stove: 48-h median: 16.7 After use of clean stove: 4.8		
4	Longitudinal (Saltzman colorimetric method)	3300 rural houses					24-h mean: 97 µg/m ³
5	Longitudinal (Saltzman colorimetric method)	3300 rural houses	17 215 samples				24-h mean: Wood: 71.2 µg/m ³ Cow dung: 67.5 µg/m ³ Crop residues: 56.1 µg/m ³

Reference	Study design	Setting	Sample size	Household air pollution indicators			
				PM _{2.5} (µg/m ³)	CO (ppm)	PM (µg/m ³)	NO ₂ (µg/m ³)
6	Cross-sectional (Berkeley UCB particle monitor)	Addis Ababa, urban slum	59 kitchens	24-h geometric mean: 818 Solid fuel stove: 1134 Kerosene stove: 637 Clean stove: 335			
7	Cross-sectional (Berkeley UCB particle monitor)	Addis Ababa, urban	69 kitchens for PM ₁₀ ; 54 kitchens for CO	24-h mean PM ₁₀ : 1580 (1580 in abstract; 793 in results)	8-h CO: 6.08		
8	Cross-sectional; measured for 130 min	Rural	26 kitchens			2.2-h total suspended particulates in kitchen: 6 795 in non-cooking areas: 4 855	
9	Cross-sectional; measured for a mean of 72 min (NIOSH 0500 and 0600)	Urban	10 houses during coffee ceremony		Area sample: 41 Personal sample (60-min average): 29	Respirable PM Area: 1 028 Personal: 1 025	

United States Environmental Protection Agency primary standards (10):

PM_{2.5}: 24-h mean: 35 µg/m³; annual h mean: 12 µg/m³

PM₁₀: annual arithmetic mean: 150 µg/m³

CO: 8-h mean: 9 ppm; 1-h mean: 35 ppm

NO₂: annual arithmetic mean: 0.053 ppm

WHO air quality guidelines (11):

PM_{2.5}: 24-h mean: 25 µg/m³; annual h mean: 10 µg/m³

PM_{2.5}: interim 24-h mean: 75, 50, 37 µg/m³

PM_{2.5}: interim annual mean: 35, 25, 15 µg/m³

PM₁₀: 24-h average: 50 µg/m³; annual arithmetic mean: 20 µg/m³

CO: 8-h mean: 10 ppm; 1-h mean: 25 ppm

NO₂: annual arithmetic mean: 40 µg/m³; 1-h mean: 200 µg/m³

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Annex 3. Ethiopian Conservation Strategy

The guiding principles of the Ethiopian Conservation Strategy (1989) related to energy are:

- intersectoral planning and development, integrating energy development with energy conservation, environmental protection and sustainable use of renewable resources;
- decentralization of the energy supply to remote and isolated areas in order to minimize investment costs;
- institutional, pricing and regulatory arrangements to ensure optimal, efficient development and use of energy resources;
- increased reliance on energy-efficient technologies, sustainable use of renewable resources and development of indigenous energy resources;
- development of renewable energy sources in preference to fossil energy sources, both to ensure sustainability and to protect the environment, and minimization of use of fossil fuels to ensure their future availability;
- participation of communities, especially women, in all aspects of resource development and use;
- encouragement of the private sector and provision of the necessary incentives for their participation in development of the country's energy resources;
- energy resource assessment, investment planning and least-cost investment programming at all levels, jointly by concerned agencies;
- energy development at all levels of planning, especially in woreda and local development plans;
- energy resource assessment, investment planning and investigation of least-cost investment programmes to be undertaken jointly by all State and private sector agencies;
- where feasible, incentives to encourage institutions and industries that consume large amounts of wood fuel to establish or contract their own woodlots; and
- Government leases for fuel woodlots for private entrepreneurs in periurban areas.

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Annex 4. Land and housing programmes

People have five options for housing in Ethiopia: private, individual houses; real estate housing; cooperative housing; joint Government and private sector housing; and Government housing. Private individual houses are constructed with investment by individuals after approval of the design and location by the responsible authorities. The investment is either direct, with cash, or borrowed from banks. Real estate housing is built by large investors who have a license to conduct this business. Their investment is usually borrowed from banks, with an initial payment and further payment in installments from their clients. The buildings are apartment blocks or villas, depending on the land that has been leased.

Cooperative housing is usually built by a group of 8–20 people, with individual contributions paid in agreed installments. Although joint venture housing is a possible modality, it has not yet been implemented. Currently, the major players in the housing sector are private individuals and the Government. Most houses have separate bedrooms, kitchen and toilet. The Ministry of Urban Development and Housing reported that progress is limited by the capacity to deliver a construction on time. Improving the capacity of the construction industry, particularly in project management, reducing waste and avoiding cost overruns, is vital to achieving the goals of housing programmes.

Integrated housing development programme

This programme is typically for urban housing and is an attempt to address the urban backlog of an estimated 1 million units. The programme allows low- and middle-income households, who often live in precarious situations, to access better housing by constructing durable, fully serviced housing units. The programme improves their living conditions, their security of tenure and access to basic services. Including clean household energy in the programme could attract carbon financing that could be used to install such energy in houses. Importantly, the programme has facilitated access to credit for the low-income population through the Commercial Bank of Ethiopia, whereas, previously, low-income households had limited opportunity for securing credit for better housing. The programme reflects

the commitment of the Government and local authorities to ensure affordable housing for low-income populations, to improve the living conditions of low-income urban dwellers and to reduce the prevalence of urban slums in Ethiopia. Currently, the programme offers three options: “10/90” (10% down payment and 90% long-term credit at a nominal interest rate), “20/80” and “40/60”. The Commercial Bank of Ethiopia administers the loan made by the Government for this programme. The 10/90 and 20/80 options target low-income groups, while the 40/60 option is for middle-income households. Houses are distributed by lottery, particularly for low-income groups, while middle-income purchasers are given priority if they can pay 100% without credit (1).

Informal housing

Informal, unplanned housing constitutes a considerable proportion of total housing, although estimates of the scale of informal urban housing

differ vastly. Informal housing is especially prevalent in Addis Ababa, where it accounted for 34.1% of all houses between 1996 and 2003.

It is still the fastest growing supply of housing (2). Periurban areas in Ethiopia are strongly tied to core urban areas, and there is no special

housing programme for these areas; the housing in these areas is mainly informal, and almost all are privately owned.

Programmes

Productive Safety Net Programme: This programme is Ethiopia's rural safety net for food-insecure households. The programme covers households in Afar, Amhara, Dire Dawa, Harari, Oromia, Southern Nations, Nationalities and Peoples, Somali and Tigray and targets households that are either chronically or temporarily food insecure. The programme provides cash and/or food transfers to households, while those with able-bodied adult labour engage in public works and receive transfers for 6 months of the year. The public works are mainly for integrated community-based watershed development, including activities such as soil and water conservation, rangeland management (in pastoral areas) and the development of community assets, such as roads, water infrastructure, schools and clinics. These works improve livelihoods (with increased availability of natural resources, including water and cultivatable land, soil fertility, increased agricultural production and improved market access) and strengthen disaster risk management, climate resilience and nutrition. The programme facilitates access to health and nutrition services, particularly for the antenatal care and nutrition of pregnant and lactating women who require temporary direct support, and also for clients of public works, whose participation in behavioural change communication sessions with regard to nutrition counts towards their obligation to participate in public works. Households that do not have labour capacity (permanent direct support clients) receive 12 months of unconditional transfers and are linked to social protection services. The programme provides technical assistance and training in crop and livestock production and other employment to enable households to increase and diversify their incomes and build their assets. While many of the people who participate in livelihood activities are referred to credit providers, the programme provides livelihood transfers to the poorest households, which do not have to be repaid, so that they

can build their assets rapidly and avoid a cycle of indebtedness. Together, these interventions strengthen resilience, improve nutrition and help households to become food sufficient and, eventually, food secure.

Sustainable Land Management Project: This Government project (4) is designed to combat land degradation, protect natural resources and restore soil fertility. The objective of the project is to reduce land degradation, increase tenure security and improve the agricultural productivity of smallholders in the intervention areas. The project conducts sustainable land management interventions in 177 watersheds in food-secure woredas prioritized by the Ministry of Agriculture and Rural Development. Interventions have started in 55 watersheds in the Amhara, Benishangul Gumuz, Gambella, Oromia, Southern Nations, Nationalities and People's and Tigray regions with the support of The World Bank, the Global Environmental Facility, German development cooperation and the Government of Finland. The project has five components:

- policy advice, to improve conditions at all levels and to scale up and implement innovative approaches and methods;
- watershed management, to improve land and water management;
- knowledge management, to develop, improve, scale-up and disseminate approaches and methods for sustainable land management with the participation of communities;
- land administration, to increase tenure security among male and female farmers with land certificates; and
- project management, to ensure operational, effective project management and coordination.

Agriculture Growth Programme: This multi-donor-funded, comprehensive programme was designed to realize the Ethiopian Government's goal of increasing sustainable agriculture growth.

It is a major component of the 5-year Growth and Transformation Plan, complements existing programmes and promotes agricultural growth in targeted, potentially rich but underdeveloped areas (woredas) of the country. The programme's strategic priorities are agricultural production and commercialization through institutional strengthening, use of best practices, development of markets and agribusiness and development and management of rural small-scale agricultural water management and market infrastructure. The programme targets 96 woredas in four

regions of Ethiopia, with 39 in Oromia, 26 in Amhara, 22 in Southern Nations, Nationalities and People's Region and 9 in Tigray. The woredas were selected for their agricultural suitability, their potential for irrigation, their infrastructure and their institutional capacity. They comprise the main beneficiaries of the programme, who are small and medium-scale farmers with an average land holding of 0.25–2.3 ha. Through the programme, women and young small-scale farmers are encouraged and enabled to increase their participation in the agricultural sector (5).

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Annex 5. International agencies and national nongovernmental organizations that address clean household energy in Ethiopia

International organizations

International institutions including The World Bank, the African Development Bank and the United Nations Development Programme play a large role in the energy sector in Ethiopia. In a developing nation such as Ethiopia, where Government funds are limited, international development agencies often take on the role of sustainability project financiers. Many of the projects funded by these agencies are renewable energy projects in rural areas.

The key partners in national health development include WHO, UNICEF, UNFPA, UN Women, The World Bank and UNAIDS, which have a joint agreement to harmonize aid and avoid duplication of efforts through joint programming within the United Nations Development Assistance Framework. The motto is: “One finance, One implementation and One report”.

The Water Supply and Sanitation Collaborative Council under the United Nations Office for Project Service has established a pooled global sanitation fund for poor people, organizations, governments and local entrepreneurs in 13 countries, including Ethiopia, to improve sanitation and hygiene. The fund has been implemented by the Ministry of Health since 2012.

Bilateral partners such as the United States Agency for International Development extend funds to capacity-building in the health extension programme and John Snow Inc for urban sanitation.

These and other partners provide good models of intersectoral coordination that may be used to generate a fund and deliver clean household energy.

Nongovernmental organizations

Several NGOs have been working in the energy sector in Ethiopia for the past 20 years. The initiatives have included solar water pumping, wind pumping, fuel-saving stoves, solar refrigeration, solar irrigation and water purification, biogas, fuel wood forestry, microhydroelectricity and solar lighting, manufacture and installation. The activities of the NGOs have often been limited by lack of funds and funders, their developmental approach to their work and their target groups. As NGOs play such a large role in development, they must be included in any energy programme from the beginning. They have made good progress in popularizing solar and micro-hydro energy.

World Vision Ethiopia is running a project to distribute over 100 000 wood stoves in its project areas in rural parts of the country. The organization is assessing appropriate fuel-saving stoves and potential local and international suppliers. The World Vision Ethiopia wood stoves project is registered as an afforestation/ reforestation project for the Clean Development Mechanism.

Gaia Association is a local NGO that promotes use of ethanol fuel and stoves that safely burn the fuel for household cooking to ensure clean indoor air. It is working in Somali Region with UNHCR in a refugee camp. It recently began

promoting the CleanCook stove for use in Addis Ababa condominiums.

GIZ cooking stove with ECO and SUN (completed) programmes and the **Netherlands Development Organisation** with technical support for the biogas programme are the leading international NGOs working in the energy sector in Ethiopia, and **HoAREC**, a national NGO, is working on establishment of renewable energy technology centres (completed) and solar lighting.

The NGOs working in partnership with the Ministry of Health are involved mainly in WASH programmes:

- Amref Health Ethiopia: maternal and child health, water and sanitation, since 2002 as a country programme;
- Plan International Ethiopia: agriculture, water, sanitation and hygiene (funded by the Government of the Netherlands);
- Water Aid Ethiopia, an international NGO;
- The Netherlands Development Organisation on water, sanitation and energy;
- World Vision on water and sanitation;
- Population Services International on malaria, HIV/AIDS and child survival (many sources of funding: UNICEF, UNOCHA, United Kingdom, USA); and
- German Federal Ministry of Cooperation and Development on renewable energy.

International initiatives for access to clean energy

United Nations Sustainable Energy for All (SE4ALL) provides efficient cooking stoves and clean fuels to poor households as part of the broader objective of energy access for all by 2030 (1).

The **Global Alliance for Clean Cooking stoves**, led by the United Nations Foundation, is helping 100 million households adopt clean, efficient stoves and fuels by 2020 (2).

The **Climate and Clean Air Coalition** works to reduce short-lived climate pollutants (3) and promotes energy-efficient stoves that lower black-carbon emissions.

The **energy sector management assistance programme** is run jointly by The World Bank and UNDP to finance analytical work to support

technical assistance, lending operations and knowledge-sharing.

Nationally appropriate mitigation actions are voluntary measures for emission reduction undertaken by developing countries that are reported by its governments to the UNFCCC. While the actions may be unilateral, undertaken by host countries, they are a common vehicle for accessing financial support for climate initiatives. They may be policies, programmes or projects implemented at national, regional or local level. The international framework is still being prepared, but some developing countries are already initiating pilot projects. Some have submitted proposals to the UNFCCC; however, none of the proposed actions include stoves, although studies on sustainable charcoal have been submitted.


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 A woman carries heavy loads of branches in Oromia, Ethiopia
Credit: John Wollwerth / Shutterstock



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ISBN 978-92-4-151449-1



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