FACILITATORS GUIDE

Community Health Volunteers (CHVs)

HOUSEHOLD AIR POLLUTION

MODULE 14

FIRST EDITION, 2021

HARAMBEE

MINISTRY OF HEALTH

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Citation

Facilitators Guide for Training Community Health Volunteers and other Health Professionals on Household Air Pollution, Module 14

Ministry of Health
Government of Kenya, 2021

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Table of Contents

List of Abbreviations iii

Foreword iv

Preface v

Acknowledgements vi

Contributors vii

Scope of Module viii

UNIT 1 Household Energy Use, Air Pollution and Principles for Prevention of Health and Environment Impacts 1

1.1 Introduction: Household Energy Use and WHO Guidelines 1

1.2 How Household Energy Use Affects Health, Safety, Climate and Environment 12

1.3 Concepts for Prevention of Adverse Health, Safety and Environmental Impacts 20

UNIT 2 Health and Safety Impacts of Household Energy Use 29

2.1 Health Impacts of Household Air Pollution 29

2.2 Recognising and Minimizing Safety Risks from Household Energy Use 40

2.3 Vulnerable Groups and Socio-Economic Impacts 48

2.4 Testing and Standards for Cleaner and Safer Cooking 54

2.5 Field visit: Consolidating Knowledge and Exploring Household Perspectives 62

UNIT 3 Household Air Pollution: Primary Prevention Strategies 65

3.1 Primary Prevention Through Improved Cooking Solutions 65

3.2 Primary Prevention Through Improved Lighting Solutions 76

3.3 Improved Space and Water Heating Solutions 84

3.4 Harm Minimization Through Ventilation 89

3.5 Harm Minimization (Reducing Exposure): Avoidance of Smoke, Fuel Drying, and other Measures 96

3.6 Tools for Supporting Change in Household Energy Technology, Fuels, and Practices 102

3.7 Addressing the Health and Environmental Impacts of Energy Supply and Use at an Institutional Level 109

UNIT 4 Monitor, Evaluate and Report on Household Air Pollution 115

4.1 Monitoring of Household Air Pollution Indicators 115

4.2 Methods for the Measurement of Household Air Pollution 119

4.3 Reporting and Interpretation of Household Energy/HAP Indicators 126

List of Abbreviations

Abbreviation	Meaning
ALRI	Acute Lower Respiratory Infection
AMREF	African Medical and Research Foundation
CHVs	Community Health Volunteers
CHEWs	Community Health Extension Workers
HAP	Household Air Pollution
CO	Carbon monoxide
COPD	Chronic Obstructive Pulmonary Disease
CCAK	Clean Cooking Association of Kenya
GIZ EnDev	Deutsche Gesellschaft für Internationale Zusammenarbeit – Energising Development
LPG	Liquefied Petroleum Gas
NIHR	National Institute for Health Research (UK)
MES	Modern Energy Stoves
MOH	Ministry of Health
PM	Particulate matter
$PM_{2.5}$	$PM_{2.5}$ refers to particles with a size (diameter) less than 2.5 micrometers
SDGs	Sustainable Development Goals
SNV	Netherlands Development Organization
TWG	Technical Working Group
VOCs	Volatile organic compounds
WEET	Women in Energy and Environmental Technology
WHO	World Health Organization

Foreword

In 2006, the Ministry of Health launched Community Health Strategy in Kenya. This was in line with Kenya's stated commitment to good health for all Kenyans. Indeed, health is not only a right but also a responsibility for all. The promotion of good health at different levels of society is the responsibility of all individuals, families, households, and communities. The purpose of the Community Health Strategy is to enable communities to improve and maintain a level of health that will enable them to participate fully in national development towards the realization of Vision 2030. Participants and Community Health Volunteers are critical in household air pollution especially in the prevention and control of pollutants.

The development of this manual has been guided by Kenya's constitution, the Vision 2030, the Kenya Health Policy 2014-2030, and other health sector policy and strategic documents. The manual aims at achieving the objectives stated in the Community Health Strategy 2020-2025 in Kenya by empowering households with knowledge and understanding of household air pollution. It endeavors to build the capacity of Community Health Volunteers on household air pollution towards achieving the aspiration of the strategy for Community Health and ultimately the Constitution of Kenya which guarantees the highest attainable standard of health as a right and not as a privilege. Further, this document will assist the Division of Community Health together with all stakeholders working in Community Health in achieving the ministerial objectives outlined in the sector's strategic documents. This manual will form part of the technical Community Health volunteers manual and be captured as Module 14.

Among other strategic partners, the development of this manual was made possible through engagement with the University of Liverpool and their NIHR Clean-Air (Africa) Global Health Research Group. With more than 30 years of research into the health impacts of air pollution and the effectiveness of prevention strategies, the University of Liverpool were able to provide state-of-the-art evidence to inform the contents of the manual and provide expertise in the direction of the delivery of training. In addition, the development of the module was funded by CLEAN-Air (Africa) and initial piloting of its contents was supported through funds provided to the team by the World Health Organization. We are very grateful to the team at the University of Liverpool for their continued support in this endeavor.

The Ministry is also grateful to its staff, partners, and all stakeholders who contributed with technical and contextual input into the development of the manual. I wish to thank you for this tremendous effort, the interest, commitment, and involvement. In particular, the Ministry expresses gratitude to the University of Liverpool, GIZ, CCAK, MES, and Moi University for their unwavering technical and financial support towards the finalization of the document.

We, therefore, urge all stakeholders to use this manual to improve the household energy use leading to enhanced health hence improving health indices.

Dr. Patrick Amoth, EBS

Ag. DIRECTOR GENERAL FOR HEALTH

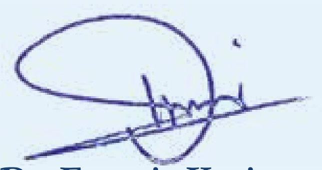
Preface

Community Health Volunteers (CHVs) are key to providing comprehensive health services at the Community Level. They have been critical players in the implementation of Primary Health Care for over four decades by mobilizing communities to take care of their health and providing basic healthcare at the community level. To enable CHVs to be more effective and efficient in reducing household air pollution and associated respiratory and cardiovascular diseases there is a need for appropriate training for both community mobilization (raising awareness and promoting options for both primary and secondary prevention) and also in the assessment of health-related air pollution issues in the community, and identification of appropriate air pollution actions at the household. This training should be planned and implemented using a standard training curriculum, informed by the best available scientific and research evidence, and manuals by well-prepared and informed trainers.

This Household Air Pollution, Health and Prevention manual is organized into 4 Units which should be applied incrementally to enable the Community Health Workers to acquire the knowledge and skills necessary for community health promotion. The sections are;

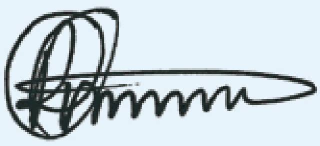
- Introduction: Household Energy Use and WHO Guidelines;
- Health, Safety, and Impacts of Household Energy Use;
- Household Air Pollution: Primary Prevention Strategies and
- Monitor, Evaluate, and Report on Household Air Pollution.

This manual will form part of the Technical Manuals of the Community Health Worker Training Curriculum. It is our expectation that all stakeholders engaged in Community Health will find this Household Air Pollution, Health and Prevention manual useful in building the capacity of the Community Health Workforce among other health workers engaged at the community levels.



Dr. Francis Kuria

Ag. HEAD, DIRECTORATE OF PUBLIC HEALTH



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This Household Air Pollution (HAP), Health and Prevention training manual would not have been developed without the financial and technical support from the University of Liverpool and the NIHR Clean -Air (Africa) Global Health Research Group. Their research and evidence synthesis over a twenty-year period has informed much of the content of the manual and development has benefitted from the leadership of respected experts in the field including Professors Nigel Bruce and Daniel Pope. In addition, the support of other partners including The Netherlands Development Organization (SNV) through the Clean Cooking Association of Kenya (CCAK), the GIZ EnDev, and AMREF International University has been crucial in progressing the manual to fruition. In the final stages of module development, the World Health Organisation's Air Quality and Health Unit, Department for Environment, Climate Change, and Health funded piloting in Uasin Gishu County, a crucial step in the journey, and we are very grateful for this support. The Ministry appreciates the support from its core partners which enabled this HAP, Health and Prevention manual to see the light of the day.

The Ministry of Health (MOH) is grateful to all those with whom we have had the pleasure to work with during the development of this manual, the corresponding curriculum, and all the annexed materials including the training PowerPoint presentations. These officers were the real champions who made this manual a reality and include. Paul Ayalo (Clean Cooking Association of Kenya - CCAK), Prudence Lihabi (Practical Action), Venice Makori (GIZ EnDev), Dan Mbingo (Kenya Industrial Research and Development Institute - KIRDI), Dr. Mbaari Kinya (WEET), and Dr. Christina Otieno (Moi University). In addition, the following MOH officers did tremendous work, they are Dan Kavoo, Peter Wanjohi, Erastus Karani, Fidelis Lagho, Catherine Munyao, and Gloria Kaari. Further, the MOH cannot forget to acknowledge Gohole A. Arthur of AMREF International University for voluntarily committing valuable time to the manual design as well as critical technical support throughout the manual development process.

Most importantly in the pursuit of this task are the following technical officers; Dr. James Mwitari (AMREF International University) was the driving force behind developing the manual and effectively coordinated the International team that steered its contents and delivery; Lolem Lokolile Bosco, and Hillary C. Chebon both of MOH effectively led the ad hoc technical team throughout the development process of the manual and were among the first facilitators to use the manual. These three technocrats worked actively as a secretariat to provide sound coordination and organization of the three retreats, the stakeholders' validation meeting, and the pre-testing exercises in the counties of Machakos, Kisumu, and Uasin Gishu. We profoundly acknowledge their support in coordinating and mobilizing the community health workers who went through the pre-testing of the manual. We say thank you all.

The MOH would especially like to thank the University of Liverpool and their CLEAN-Air (Africa) Global Health Research Group, who steered the content of the module, provided financial and technical support to draft the module, for Technical Working Group meetings, and for piloting the manual. Special thanks go to Prof. Dan Pope, Director of CLEAN-Air(Africa), and Emeritus Prof. Nigel Bruce who led the initiative. We would like to also acknowledge the efforts of Dr. Diana Menya of Moi University, who provided input to the Technical Working Group on behalf of CLEAN-Air(Africa).

Finally, we would like to thank the Technical Working Group (TWG) on Health, Energy, and Climate who guided and provided the foundation for all the processes pursued. The group played an ultimate role in prioritizing this activity and ensuring that it was fast-tracked. Most importantly, we wish to thank the Clean Cooking and Community health stakeholders for validating the document and finally giving it the approval for circulation and implementation.

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Scope of Module

The use of solid fuels and kerosene and other biomass burned in inefficient stoves leads to high levels of Household Air Pollution (HAP). It is responsible for large amounts of pollutants, like particulate matter (PM), carbon monoxide (CO), poly-aromatic hydrocarbons, formaldehyde, and many more. The main diseases attributable to HAP are those of the respiratory system (including child pneumonia, chronic obstructive pulmonary disease, and lung cancer) and the cardiovascular system (including stroke and ischaemic heart disease). These diseases are the top five leading causes of death in Kenya at 46% (2014) and responsible for 26% of all deaths in Kenyan hospitals. WHO (2016) estimates indicate that in Kenya, HAP prematurely killed 15,140 (WHO, 2016) people each year, although recent figures from IHME (2020) indicate that more that 22,000 now die early from this cause. Other diseases or conditions of importance include asthma, adverse pregnancy outcomes, cataracts, tuberculosis, carbon monoxide poisoning, risk of burns from stoves/ fuels, and musculoskeletal injuries/ accidents from gathering and carrying wood fuel. In addition, HAP contributes to ambient air pollution, impacts on the environment, and climate and the use of solid fuel exacerbates deforestation.

Realizing the health impacts arising from HAP, the Kenya Ministry of Health (MOH) and partners this year developed this HAP, Health and Prevention training manual in order to strengthen the capacity of health workers to help prevent household air pollution and associated illness in their communities. The overall scope of the manual, therefore, relates to the adverse impacts of reliance on polluting solid fuels, biomass, and kerosene for household energy in Kenya and on primary and secondary prevention strategies to address them. Other indoor environments and non-combustion related indoor air pollutants like molds or volatile organic compounds (VOCs) and a broader perspective on institutions are also touched upon.

The role of members of the community and of the community health volunteers is addressed in respect to energy use, air pollution, and environmental aspects including climate impacts with reference made to green building designs.

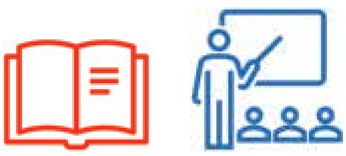
This manual targets members of the community and the community health workforce. However, other cadres of health workers largely in preventive and promotive health who include public health officers and technicians, nutritionists, and those in health promotion, are also targeted in this manual as recommended by the Kenya WHO report (2018) on opportunities for transition to clean household energy in Kenya through capacity building of health workers.

It's therefore hoped that the manual will be used to strengthen the capacity of a range of health workers to reduce the adverse health and environmental impacts of household energy use of solid fuels, biomass and kerosene and associated HAP through the promotion of cleaner fuels for cooking, lighting or heating, as well as in promoting the best available technologies and scaling up green building designs.

UNIT 1

Household Energy Use, Air Pollution and Principles for Prevention of Health and Environment Impacts

1.1 Introduction: Household Energy Use and WHO Guidelines



Purpose:

To equip participants with knowledge and understanding of:

- Household energy use globally, regionally, and nationally, including fuel and technology types and trends.
- The rationale for, and main recommendations of, the WHO Indoor Air Quality Guidelines for Household Fuel Combustion (2014).
- The relevance of these WHO Guidelines to the management of Household Air Pollution (HAP).

Training objectives	By the end of this unit, the participant should: • Be familiar with levels of, and trends in, the use of different household energy sources globally, regionally in Africa, and nationally in Kenya. • Understand the rationale for and relevance of WHO Guideline recommendations for mitigating the adverse effects of household energy use and HAP.
Duration	 **90** mins
Methodology	Mini lectures, group exercises on energy use, and facilitated discussion.
Materials	LCD projector with a laptop, flipcharts with marker pens, video footage of solid fuel use, and HAP.
Activity	Gaining familiarity with information on household energy use and WHO Guideline recommendations.

Facilitation Step 1.1.1: Household energy use

1. Ask the participants (in groups) to discuss and write down (e.g. on a flipchart) what they know about household energy use in Kenya, both nationally and locally. They should be encouraged to think about both the fuels (e.g. wood, charcoal, LPG, etc.) as well as the technologies (e.g. stoves, lamps, etc.) employed for cooking, lighting, heating, and any other uses in and around the home.
2. Then ask the groups to present their 'reports' and harmonize the responses.
3. Present data [see Resource 1.1] on household energy use globally, regionally, and nationally for Kenya.
4. Carry out Exercise 1.1.1 on cooking fuels using the Q&A provided.
5. Carry out Exercise 1.1.2 on lighting fuels using the Q&A provided.

Resource 1.1.1: Household energy use and trends globally, regionally, and nationally

Sources of information:

Information on household energy use is obtained from questions to households in national censuses, and in large sample surveys such as the Demographic and Health Survey (DHS), World Health Survey (carried out by WHO), and the Multiple Indicator Cluster Survey (MICS).

To date, the questions used at the national scale have been quite simple, asking about the main fuel used for cooking. Lighting, heating, and other needs, and information about secondary fuels, ventilation, chimneys, etc., have not been routinely included because the surveys are already long and complex. These additional questions have been studied from time to time, however, in special survey modules.

The routine information on cooking fuel is compiled by WHO. The key indicator is the **primary reliance on clean fuels and technologies**, which is reported in a global database and regularly updated. Clean fuels are electricity, gas [Liquefied Petroleum Gas (LPG) and natural gas], biogas, and alcohol fuels. Solar cookers are also included but are used by very few as a primary means of cooking.

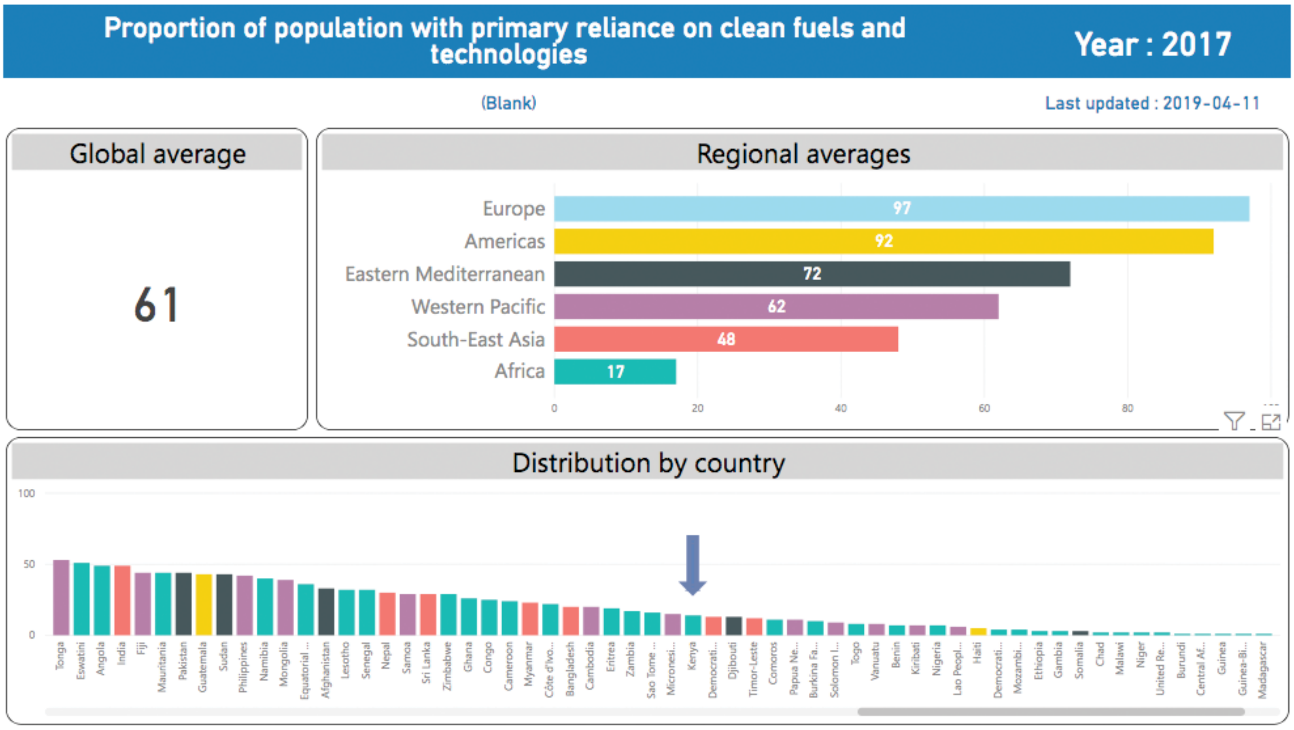
Global, regional, and national (Kenya) household energy use:

The WHO Sustainable Development Goal (SDG) data dashboard presents data for the World, the WHO Regions, and by country, and is available at: [http://apps.who.int/gho/data/node.sdg.7-1-viz?lang=en]. The situation in 2017 (currently, the most recent data available from this source) is shown in the graph below, with the bar for Kenya marked with an arrow.

Overall, global primary reliance on clean fuels and technologies stands at 61%, with substantial variation by region from 97% in Europe to 17% in Africa. This means that globally, 39% **do not rely primarily on clean fuel**, rising to 83% in Africa.

Cooking fuel use in Kenya is typical for Sub-Saharan Africa, with just 14% (in 2017) relying primarily on clean fuels and technologies for cooking. This means that more than 80% of the population is still dependent on 'polluting' fuels, namely wood, dung, crop wastes, charcoal, and kerosene. This figure is typical for countries in sub-Sahara Africa.

Clean fuels



Source WHO: http://apps.who.int/gho/data/node.sdg.7-1-viz?lang=en

Trends in household energy use in Kenya:

The WHO database provides us with information on trends in primary reliance on clean cooking fuels and technologies, for the world, and by region and country. These data (shown as % of populations in the table below) emphasize the situation with clean energy access in Africa and the relatively slow pace of change in comparison with other regions of the world.

WHO region	2000	2005	2010	2015	2016	2017
Africa	**13**	**14**	**15**	**16**	**17**	**17**
Americas	86	89	91	92	92	92
South-East Asia	20	26	33	40	41	48
Europe	92	95	96	97	97	97
Eastern Mediterranean	57	63	67	70	71	72
Western Pacific	51	55	59	62	63	62
(WHO) Global	49	53	56	59	59	61

Source WHO: http://apps.who.int/gho/data/view.sdg.7-1-data-reg?lang=en

For Kenya, the percentage of the population with primary reliance on clean fuels and technologies has risen from less than 5% in 2000 (and 2005) to 14% in 2017 (the most recently available data from this source), slightly below the regional average.

Country	2000	2005	2010	2015	2016	2017
Kenya	<5	<5	8	13	13	14

Source WHO: http://apps.who.int/gho/data/node.sdg.7-1-data?lang=en

A more detailed picture of household energy use is available from national surveys, including the Population and Housing Census and The Kenya Integrated Household Budget Survey (KIHBS) which is carried out every ten years or so. The most recent was conducted in 2015/16 and involved 11,415 households across the country. The table below shows the main fuels used by urban and rural populations for **cooking** and **lighting** as reported from the KIHBS (2015/16):

Cooking fuel (%)			
Fuel	**Urban**	**Rural**	**National**
Firewood	16.1	84.3	54.6
Electricity	2.0	0.3	1.0
LP Gas	27.6	2.5	13.4
Biogas	0.2	0.2	0.2
Kerosene	29.0	2.3	14.0
Charcoal	21.0	8.9	14.6
Straw, shrubs, grass	0.0	0.0	0.0
Animal dung	0.1	0.0	0.1
Crop residues	0.0	0.3	0.2
Other	2.4	0.9	1.6
Total number in survey	**4,972**	**6,442**	**11,415**

Ministry of Health, Uganda

Ministry of Health, Uganda

Lighting fuel and technology (%)			
Fuel	**Urban**	**Rural**	**National**
Mains electricity	73.0	17.1	41.4
Generator	0.4	0.5	0.5
Solar energy	4.2	20.6	15.7
Kerosene lantern	9.2	20.6	15.7
Kerosene tin lamp	8.5	27.7	19.3
Kerosene pressurized lamp	0.1	0.3	0.2
Fuel wood	0.2	2.7	1.6
Gas lamp	0.0	0.0	0.0
Battery lamp or torch	1.5	7.3	4.8
Candles	1.7	0.3	0.9
Biogas	0.0	0.0	0.0
Other	0.6	1.4	1.1
Not stated	0.5	0.2	0.3
Total number	**4,972**	**6,442**	**11,415**

Source: KIHBS 2015/16 Kenya National Bureau of Statistics 2018

The KIHBS survey also includes information on the type of cooking appliance, which we will return to at the start of Unit 3.1 when we start to look at the options for cleaner cooking.

The 2019 Population and Housing Census provides more recent information on cooking fuels. This shows that nationally, as of 2019, two-thirds primarily used wood or charcoal (27.0% urban, 91.8% rural), about one-quarter were primarily using gas, mainly LPG (53.6% urban, 5.9% rural) and 7.8 were primarily using kerosene (17.7% urban, 1.6% rural).

Information on primary and secondary fuel use in surveys

Surveys (such as the DHS and KIHBS) and the Census collect information on the primary (main) fuel used for cooking or lighting, but not secondary fuels.

This means we do not know whether a home using, for example, charcoal as the main fuel might also use LPG for some cooking. Similarly, we do not know whether a home using mainly electricity for lighting also uses kerosene at times.

This information on secondary fuel use is important. In the first example, knowing that the home also uses some LPG tells us that the household has obtained a gas cooker and bottle and have some experience of using this clean, modern fuel. In the second example, we may think the home is using a clean fuel for lighting but in fact they are also using kerosene which causes significant air pollution, as well as being a safety risk.

New questions have recently been developed for these surveys which do ask about secondary fuel use. This means that in future, the data available on household fuels will include information on main and secondary fuels and technologies.

Exercise 1.1.1: Q&A and group discussion on cooking fuels use in Kenya

1. Based on the KIHBS data table, what are the most common cooking fuels in the urban and rural areas?
    - Urban = Kerosene, LPG and charcoal
    - Rural = Firewood overwhelmingly, then charcoal
2. The KIHBS report comments on trends since the last survey in 2005/06: LPG gas use grew from 3.5% nationally in 2005/06 to 5% in the 2009 Census, to the 13.4% seen in the 2015/16 survey. The 2019 Census reports primary LPG use by 24.4%. What do these figures tell us?
    - LPG is now used as a cooking fuel by around one-quarter of the population of Kenya.
    - The use of LPG is increasing quite quickly, especially in the urban areas where just over 50% use LPG as their primary cooking fuel
    - There is also some growth in rural areas, albeit from very low levels.
3. Why is it important to have information about secondary cooking fuel use, in addition to knowing the main fuel?
    - If the secondary fuel is cleaner and more efficient, we then know that the household has the stove and fuel, and some experience of using it.
    - If the secondary fuel is more polluting, we then know that there is still an important source of pollution in the home.

Exercise 1.1.2: Q&A and group discussion on lighting fuels use in Kenya

1. Based on the KIHBS data table, what are the most common lighting fuels in the urban and rural areas?
    - Urban = mains electricity; Rural = kerosene
2. What lighting technology (that is, the type of lamp) is most common in rural areas?
    - Kerosene tin lamp – this is important information as this is the most polluting type of kerosene lamp.
3. The report notes that kerosene as a lighting fuel in rural areas declined from 86.4% in the 2005/06 survey to 48.6% in 2015/16. What has taken its place?

- The decline in kerosene use has been matched by greater use in 2015/06 of solar lamps (20.6%) and electricity (17.1%); these are encouraging trends.

Facilitation Step 1.1.2: Data collection opportunities

1. Ask the group whether they think that CHEWs and CHVs could, during their routine work, collect and report information on energy use in the home.
2. Discuss the responses, noting that CHIS form MOH 513 is used to record information on home visits, and MOH 513 (Summary) to compile and report the data. Questions on household energy use have now been added; we will look at this again in **Unit 4**.

REPUBLIC OF KENYA – MINISTRY OF HEALTH

MINISTRY OF HEALTH

Community Health Services
"Afya Yetu, Jukumu Letu"

HOUSEHOLD REGISTER
MOH513

NAME OF CHU:		COUNTY:	
MCHUL CODE:		SUB COUNTY:	
LINK FACILITY:		DIVISION:	
NAME OF CHV:		LOCATION:	
NAME OF VILLAGE:		SUB LOCATION:	
START DATE:		END DATE:	

Front page of MOH 513, the Household Register.

This form currently includes data collection on water and sanitation.

In the future, information will also be collected on household energy use.

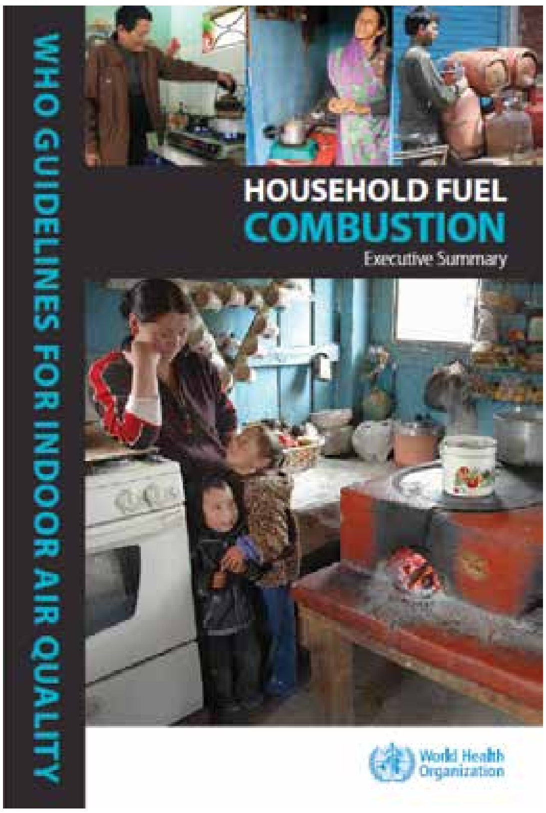
Facilitation Step 1.1.3: WHO Guidelines for household fuel combustion

1. Present key points on the purpose of the WHO Indoor Air Quality Guidelines on Household Fuel Combustion (Resource 1.1.2).
2. Summarise the main Recommendations of the WHO Guidelines, explaining the rationale for each (Resource 1.1.2).
3. Carry out Q&A Exercise 1.1.3 ensuring trainees understand the answers.

Resource 1.1.2: WHO Indoor Air Quality Guidelines for Household Fuel Combustion

Rationale – Addressing the Burden of Disease from HAP:

The WHO Indoor Air Quality Guidelines for Household Fuel Combustion (2014) were developed to address the substantial burden of disease and mortality caused by HAP. In 2016, the most recent year for which WHO calculations for this disease burden are currently available, HAP was responsible for **3.8 million** premature deaths, which is almost 8% of global mortality.



These deaths, and the associated ill-health, affect people of all ages. The causes linked to HAP exposure include respiratory infections in young children and a range of respiratory, cardiovascular, and cancer conditions in adults. In **Unit 2.1**, we take a closer look at how HAP exposure leads to these diseases, and the resulting death rates across the regions (including Africa) and in Kenya.

Development of the WHO Air Quality Guidelines for Household Fuel Combustion:

The remit of WHO's includes the production of evidence-based guidelines on the levels of safe levels of indoor and outdoor air pollutants, and the risks from exposure to higher levels.

The Air Quality Guidelines for Household Fuel Combustion addressed the following questions:

- What levels of pollution are household members exposed to?
- What are the disease conditions caused by exposure to this pollution, and how strong is the evidence?
- To what level do pollutants need to be reduced to avoid the risks from exposure?

- How effective are different fuels, technologies (i.e. stove type, ventilation, etc.) in reducing exposure to the levels needed to prevent ill-health?
- Are there other important risks for people habitually using traditional fuels, stoves, lamps, etc., such as burns, scalds, and poisoning, that also needed attention?
- What are the social, economic, environmental, and climate impacts of traditional household energy use?

The main conclusions from reviewing the evidence on these questions are discussed further in **Unit 2** (health and safety impacts) and **Unit 3** (cleaner fuels and other changes to reduce adverse effects on health, safety, and the environment).

The Guidelines Committee then developed recommendations to assist countries and other agencies in achieving the changes needed to reduce - and ultimately completely prevent - the adverse health effects of household fuel combustion. The key points from the recommendations are provided below:

Recommendation 1: Reduce emission rates

- It was found that – to avoid adverse health effects - exposure to the most important pollutant, particulate matter (the key measure of which is $PM_{2.5}$ – see definitions on page iii), needed to be reduced from the very high levels people were typically exposed to, down to really quite low levels.
- It was recommended that the most effective way to achieve this was to **reduce the emissions** 'at source' from stoves, lamps, and other devices to low levels; guidance was therefore provided on what these emission rates should be.
- This guidance was provided for the two most important and commonly measured pollutants, namely $PM_{2.5}$ and Carbon Monoxide (CO – see definitions on page iii).

In order to measure emission rates, standardized testing would be required. Internationally agreed **laboratory testing procedures** and a set of **emission rate tiers** that help assess how effective stoves are in reducing emissions have been developed by the **International Organisation for Standardization** (ISO).

These ISO Standards can help decide what fuels and devices should be recommended and are further described in Unit 2.4 while their application in practice is covered in Unit 3.1.

Recommendation 2: Policy during the transition to clean fuels

The WHO Guidelines evidence reviews found that, in practice, only clean fuels such as gas, electricity, ethanol, etc., can deliver levels of pollution in the home that guarantees health is protected.

Recognising that, while many homes in developing countries with supportive policies will be able to switch to clean fuels in the short-term (i.e. within five years or so), there are many other households in more rural and poorer areas for whom this transition will take longer.

For this second group, it was recommended that intermediate steps (such as cleaner-burning improved solid fuel stoves) that offer **substantial health benefits** should be prioritized. The ISO emissions testing standards referred to above provide a practical means of assessing which stove/fuel combinations can offer such benefits, and which do not.

Recommendation 3: Household use of coal

The use of coal, particularly unprocessed coal, as a household fuel for cooking and heating, has been shown to lead to serious health problems and it was recommended that this fuel should not be used in the home.

Coal is rarely used as a household fuel in Africa (apart from South Africa), and almost none is used in Kenya, so this recommendation is less applicable in the East African setting.

Recommendation 4: Household use of kerosene

The use of kerosene for cooking, lighting, and heating was found to be linked to a wide range of serious health outcomes, although the scientific evidence was judged to be not yet as strong as for solid fuels.

On the other hand, kerosene use presents significant risks for burns and fires, and where improperly stored (e.g. in soft drink bottles), of poisoning for children who drink the fuel.

Accordingly, a recommendation was made strongly discouraging the use of kerosene as a household fuel.

Recommendation on securing health and climate co-benefits

The incomplete combustion of solid fuels which occurs in simple stoves contributes substantial amounts of important short-acting climate-warming emissions such as methane and black carbon. LPG is a fossil fuel, so its use makes a net contribution to CO_2 in the atmosphere. If electricity is renewably generated there is little climate impact, but of course, much electrical power is produced from fossil fuels.

Policy on clean and efficient household energy, therefore, has the potential to benefit both health and the environment. Accordingly, the WHO Guidelines recommended that policy on climate change should consider action on household energy and carry out assessments to maximize health and climate gains.

Summary:

The WHO Air Quality Guidelines for Household Fuel Combustion provide a valuable resource of evidence and policy guidance that can support the work of Participants, Community Health Volunteers, and the partners and communities with which they co-operate and support.

The full set of resources for the Guidelines is available at:
https://www.who.int/airpollution/guidelines/household-fuel-combustion/en/

Exercise 1.1.3: Q&A and group discussion on WHO Guidelines for household fuel combustion

1. Why do the WHO Guidelines recommend that switching to clean fuels such as LPG, electricity, ethanol or biogas should be the priority?
   - Pollution must be reduced to very low levels to avoid the diseases caused by HAP.
   - Studies have shown that even improved solid fuel (e.g. wood, charcoal) stoves do not achieve these low levels of pollution when in everyday use in the home.
2. The WHO Guidelines recognise that not everyone will be able to change quickly to clean fuels. In these circumstances, intermediate steps (e.g. improved wood stoves) bringing some pollution and efficiency benefits should be promoted. How can we be sure that a stove does have these benefits?
   - The stove should be tested for emissions, efficiency, and other aspects of performance.
   - This should be done using standard test protocols in a certified laboratory – we will look at this again in **Unit 2.4**.

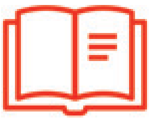
3. Why do the WHO Guidelines recommend that kerosene should not be used as a household fuel?

- Kerosene produces pollution and there is growing evidence about the damaging effects on health.
- Kerosene is a common cause of burns and fires.
- Kerosene that is not stored in child-proof containers is a common cause of poisoning in children.

Sources and Reading Materials

1. WHO Household Energy Database: https://apps.who.int/gho/data/node.sdg.7-1-viz?lang=en
2. KIHBS 2015/16 Kenya National Bureau of Statistics 2018: https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/KNBS_-_Basic_Report.pdf
3. WHO Indoor Air Quality Guidelines: Household Fuel Combustion (2014): https://www.who.int/airpollution/guidelines/household-fuel-combustion/en/
4. Kenya Economic Survey 2020 (KNBS) Data from Chapter 21 based on 2019 Population and Housing Census: https://www.theelephant.info/documents/kenya-national-bureau-of-statistics-economic-survey-2020/

1.2 How Household Energy Use Affects Health, Safety, Climate and Environment



Purpose:

To equip participants with knowledge and understanding of:

- The causes and constituents of household air pollution from household energy use.
- The implications for safety in and around the home.
- The impacts on the local environment and climate.

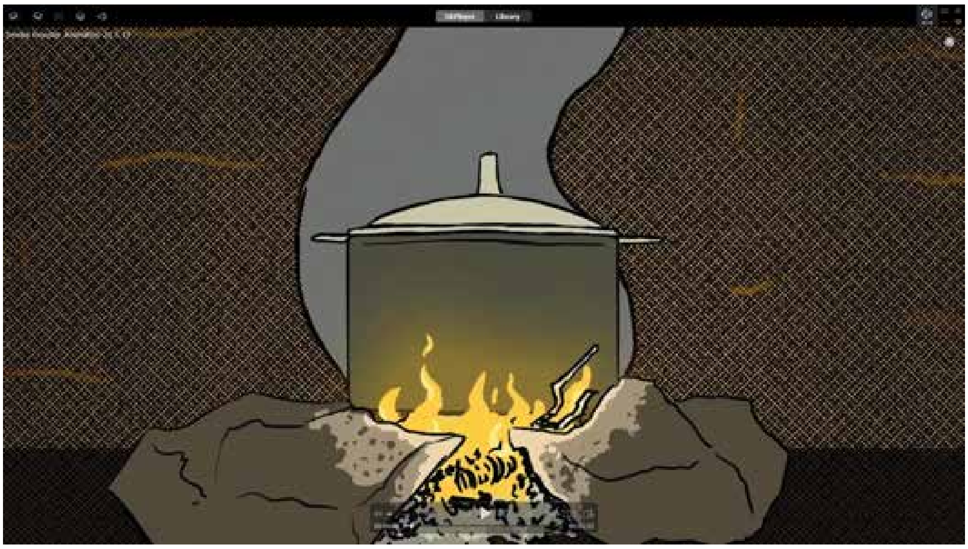
Training objectives	By the end of this unit, the participant should be able to define, in respect of household energy use: • Household Air Pollution (HAP) and Ambient Air Pollution (AAP). • Concepts of emissions, air quality, and exposure and how these are linked. • Key pollutants [small particulate matter ($PM_{2.5}$) and carbon monoxide CO)]. • Safety risks. • Environmental impacts including deforestation, and climate change.
Duration	 **60** mins
Methodology	Groupwork, facilitated discussion, and mini lecture.
Materials	LCD projector and laptop, video, flipcharts and marker pens.
Activity	Understanding the relationships between emissions, pollution and exposure, definition of terms.

Facilitation Step 1.2.1: Emission sources, air pollution and exposure

1. Show the Smoke Monster video.
2. Ask the participants, in groups, to discuss and record what the video shows about sources of HAP, levels of pollution and exposure of people in and around the home.
3. Present the concepts of emissions, air quality, and human exposure leading to adverse health effects, using the chart (Figure 1.2.1) and information in Resource 1.2.1.
4. Check understanding and answer questions.

Smoke Monster Video

This is a short, animated video lasting around 3 minutes, that was produced by Plymouth University for the Ministry of Health, Uganda. It provides an engaging introduction to the health risks from household air pollution, and what can be done. It covers cooking and lighting, and also draws attention to smoking. Suggested solutions include clean cooking fuels and lighting and better ventilation.



Resource 1.2.1: Concepts of emissions, air quality, and exposure

The combustion (burning) process is key to understanding the potential consequences of household energy use. In traditional and simple stoves and devices, combustion is very inefficient. This is in contrast to gaseous (e.g. LPG) or liquid (e.g. ethanol) fuels which burn very efficiently. Some types of improved solid fuel stoves can improve the efficiency of combustion, saving fuel and reducing emissions, but cannot (yet) match the efficiency of liquid or gaseous fuels.

Emissions from the stove lead to high levels of air pollution in and around the home, and in turn to exposure of people working and living in this environment.

Inefficient and incomplete combustion leads to high levels of **emissions** of **products of incomplete combustion** (PICs). These PICs contain the **pollutants** we are concerned about – many thousands of chemicals that can harm human health.

If the home is **ventilated**, or the stove has a chimney or flue, some of the emissions escape to the outside resulting in lower levels of pollution in the home. Of course, these emissions do not disappear; they contribute to **outdoor (ambient) air pollution** affecting neighbours and may re-enter the home.

The level of **exposure** to household members also depends on several factors. The air quality in and around the home is most important, but another key factor is the duration of time that a person stays in the polluted environment. It is possible to reduce exposure by moving away from the most polluted area(s), if that is a practical option.

It is now known that exposure to air pollution can cause a wide range of disease conditions from pregnancy through to old age; this can happen because the various chemical substances breathed into the lungs cross into the bloodstream and reach every organ of the body. The range of disease conditions, and the ways in which exposure to this pollution harms human health, is explored further in Unit 2.1.

It is important to remember that **tobacco smoking** is another important source of air pollution in and around the home. This lifestyle health risk is addressed thoroughly in Module 13(a) on Non-Communicable Diseases (for which it is one of the most important causes). It should also be considered when addressing HAP from household energy use, as the benefits of clean cooking and lighting may be lost if significant levels of tobacco smoking continue to take place. We return to this when looking at advice to households and communities in Unit 3.

An overall perspective on the impacts of household energy use

The following diagram and sections in text boxes serves as a resource for the Facilitator leading the discussion with questions and answers:

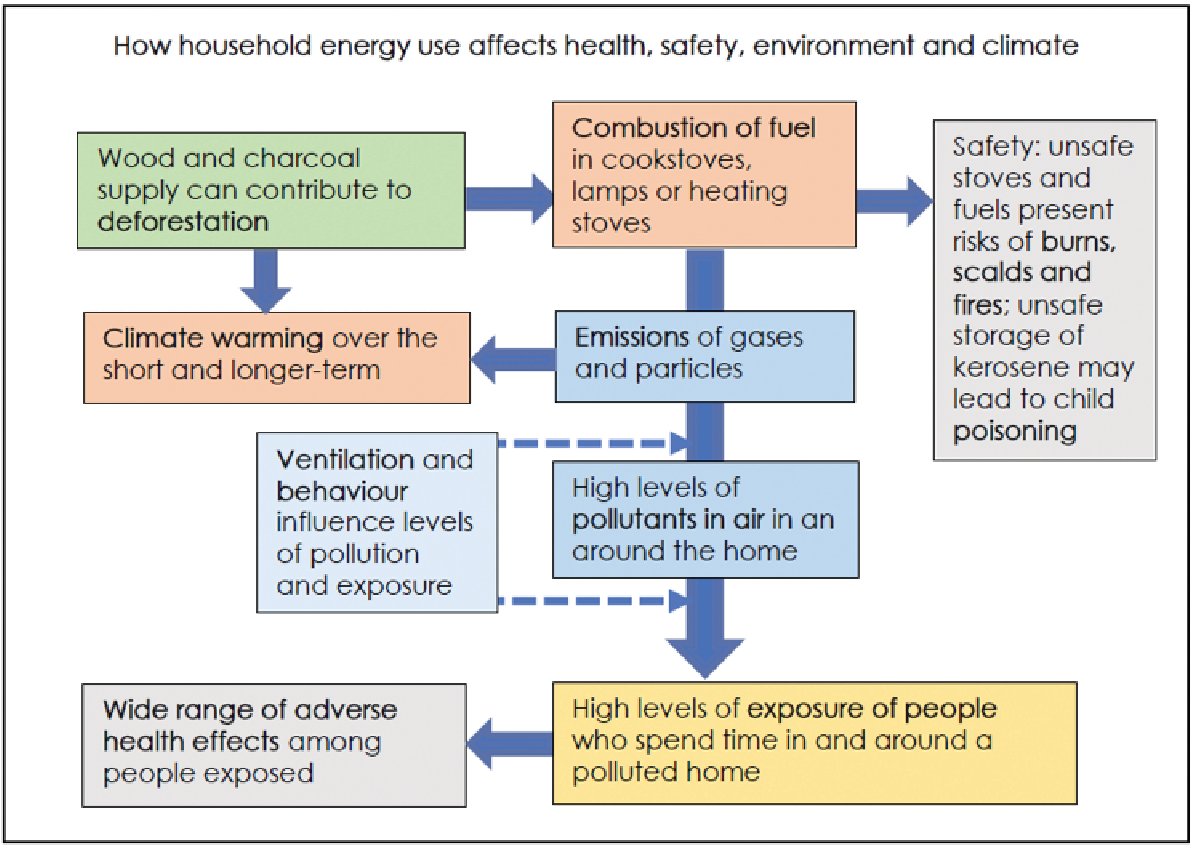


Chart 1.2.1: *Inter-linkages between the supply of energy and fuel, combustion in the home, pollution, exposure and health effects, along with other impacts on safety, environment, and climate.*

Facilitation Step 1.2.2: Household energy, safety, and the environment

1. Ask the participants to discuss and record how the supply and use of household energy affects
   a. Safety in and around the home;
   b. Forest resources;
   c. Climate.
2. Report back and discuss responses.
3. Present key points from Resource 1.2.2.
4. Check understanding and answer questions.

Resource 1.2.2: Household energy, safety, and the environment

Energy supply and deforestation

The use of household energy must start with obtaining the fuel, whether this be the collection of wood and other 'free' biomass fuel, or the supply and purchase of fuels that are bought, such as charcoal, gas, or electricity.

Although many human activities (including sourcing building materials, agriculture, etc.) contribute to deforestation, the collection of wood fuel and production of charcoal can impact quite significantly, especially where forest resources are not sustainably managed. Loss of forest cover can contribute to soil erosion and flooding.

Charcoal production, a fuel widely used in urban areas, is an important cause of deforestation.

Safety risks: burns and poisoning

The use of traditional stoves and kerosene lamps present serious safety risks, especially to those using them and to young children.

Cooking stoves on the floor can result in children being burned by hot fuel or igniting the cook's clothes, while unstable pots may lead to scalding by spillage of hot liquids.

Kerosene stoves and lamps are a common cause of fires, while kerosene fuel that is purchased or stored in soft drink bottles results in many cases of poisoning of children who drink the fuel.

Contracture of a woman's hand caused by a burn from a cookstove.

Climate impacts

Emissions from the incomplete combustion of solid household fuels and kerosene, including PICs such as methane and black carbon, have very powerful short-term warming effects on the climate.

Longer-term warming effects occur mainly with carbon dioxide (CO_2) emissions. Biomass fuels such as wood, if fully renewably harvested, can – in theory at least - be climate neutral in terms of CO_2 emissions. Experience shows, however, that most biomass fuel for household use is not harvested renewably, so there is a net contribution to warming from CO_2. In addition, as the combustion process with solid biomass fuel is typically very incomplete (even with 'improved' solid fuel stoves), so the overall effect on the climate includes warming from both PICs (short-term) and CO_2 (longer-term) emissions.

Cleaner burning fuels also have impacts on the environment and climate. For example, although LPG burns very efficiently with minimal emissions of PICs (short-acting climate-warming gases) and does not impact on forest reserves, it is a fossil fuel so inevitably makes some contribution to atmospheric CO_2. The chemical composition of

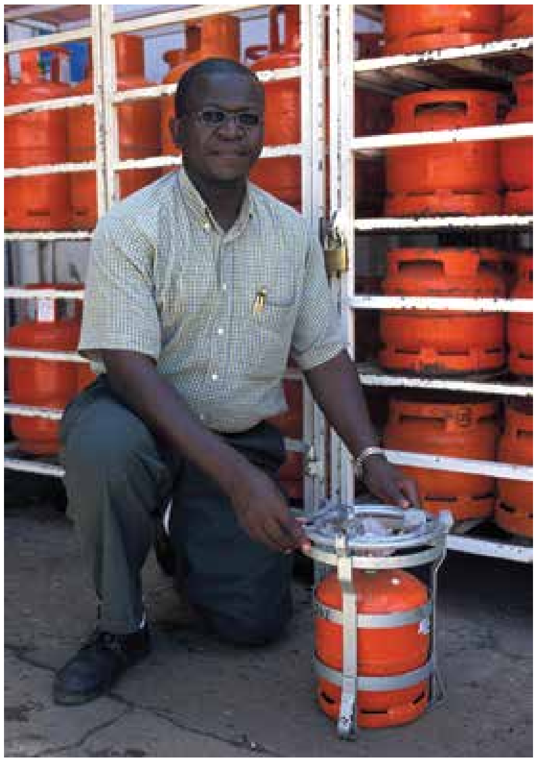
LPG (with a relatively large hydrogen to carbon ratio), however, means that for the energy delivered, it contributes far less CO_2 than other fossil fuels such as coal.

LPG can also be manufactured from renewable materials and work is underway to develop the potential of this clean, renewable fuel that can be stored, transported, and burned in standard LPG equipment.

Alcohol-based fuels (ethanol and methanol), although not yet very widely used, are manufactured from renewable feedstock and are clean-burning, so provide another potentially valuable household energy option with health and climate co-benefits.

For electricity, the impacts on the environment depend on how and where this is generated, with much lower climate warming impacts for hydroelectric or solar-generated power, compared with coal, gas, or oil-fired power stations.

The short and longer-term climate impacts of alternative fuels and technologies are summarized and further discussed in **Unit 3**.



© Nigel Bruce/Practical Action

LPG is a fossil fuel so contributes to net CO_2 emissions, but burns very efficiently.

Facilitation Step 1.2.3: Definitions of key pollution terms

1. Present the definitions of the main terms listed in Resource 1.2.3.
2. Check understanding and answer questions.
3. Show and attach wall-chart of definitions; encourage participants to use this as a reference throughout the training.

Resource 1.2.3: Definitions of the main terms used in work on air pollution, health, and climate

Household Air Pollution (HAP) is produced from the combustion of household fuels for producing energy for the tasks outlined above. The pollution (smoke) comprises a range of gases and particles that are hazardous to health and also impact on the climate. Two of the most important and commonly measured health-damaging pollutants are particulate matter (PM) and carbon monoxide (CO) described below.

Although combustion-related pollutants are the primary concern of Module 13(b), there are other pollutants in and around the home that can adversely affect health and/or the environment. These include biological pollutants such as mold spores, chemicals from materials used in furniture, and gases used in refrigeration.

Photos © Nigel Bruce/Practical Action

[Left] Household air pollution in a Kenyan home from an open fire; [Right] Pollution from cookstoves causing ambient (outdoor) air pollution.

Particulate Matter (PM) is complex mixtures of pollutants that collect in 'particles' of various sizes, ranging from ultrafine (invisible) to visible dust particles. Those of greatest concern to health are particles less than 10 microns (a micron is one-millionth of a metre; it is signified by the symbol μ) since these can pass through the nose and upper airways into the lungs. Particles of 2.5μ or less in diameter can penetrate deep into the lungs and pass into the circulation, so are generally taken as the best measure of the health-damaging potential of particulate matter. PM emissions are an important component of ISO testing and standards. The measurement of exposure to PM is covered in Unit 4.2.

Carbon Monoxide is a colourless and odourless gas produced by incomplete combustion of fuels that contain carbon that is toxic by virtue of its ability to reduce the ability of blood to provide oxygen to the organs of the body. While lower levels of exposure cause drowsiness and headache, higher levels cause unconsciousness and death. CO emissions are an important component of ISO testing and standards. The measurement of exposure to CO is covered in Unit 4.2.

Ambient Air Pollution is pollution in the general environment and is often also referred to as outdoor air pollution. Ambient air pollution contains particles, gases, and biological material in the same way that indoor or household air pollution does, although the sources also include traffic, industry, power generation, etc. Household fuel combustion can contribute significantly to ambient air pollution, in some parts of the world as much as 30-40% of all ambient pollution derives from household sources. This transfer of pollutants from within the home to the outside air works the other way around: ambient air pollution makes its way into the home, so in a heavily polluted environment, even using clean fuels in the home will not prevent pollution inside the home. This is why the best solution to HAP is to reduce emissions at the source, as this directly prevents pollution in the home, as well as reducing emissions to the ambient air which not only re-enter the home, but also affect neighbours and the surrounding environment.

Health impacts: A wide range of health impacts are now known to be caused by exposure to HAP including adverse pregnancy outcomes, respiratory and circulatory disease, and cancer. In general, the health effects of HAP exposure are similar to those for cigarette smoking, which is after all just another form of exposure to smoke from burning biomass (tobacco leaves). These health impacts, including the specific disease outcomes, numbers of people affected, mechanisms, and vulnerable groups, are all explored further in Unit 2.

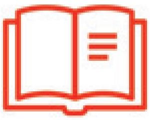
Climate Change refers to an increase in global temperatures, both on average but also regionally as local effects are also recognized. Climate change includes warming and the "side effects" of warming - including melting glaciers, heavier rainstorms, or more frequent drought. It also includes the health, social and economic consequences for people affected by these changes. Climate warming is caused mainly by short-acting (e.g. methane and black carbon) and longer-acting (e.g. carbon dioxide – CO_2) emissions from the combustion of fuels containing carbon, especially fossil fuels such as coal, oil (diesel, petrol, etc.) and gas. Although biomass fuels such as wood and crop wastes can, in theory, be carbon neutral as the CO_2 emitted can be absorbed back into new forest growth or crops, in practice, there are two reasons why this is not happening: (a) only about 30-40% of biomass used for fuels is replanted (and in some areas considerably less), and (b) combustion of biomass in the home is very inefficient, producing substantial amounts of 'products of incomplete combustion' (PICs) which include the powerful warming gases methane and black carbon. Approaches to addressing climate change are essentially twofold, involving:

- **Mitigation:** efforts made to reduce emissions with the long-term goal (as agreed in Paris in 2016) of keeping the increase in global average temperature to well below 2°C above pre-industrial levels; and to limit the increase to 1.5°C, since this would substantially reduce the risks and effects of climate change.
- **Adaptation:** actions taken to increase the resilience of populations at greatest risk from the physical, economic, and social effects of global warming.

Reading Materials

1. Gender, Climate Change and Health report by the World Health Organization.
2. United Nations Framework Convention on Climate Change.
3. WHO (2016), Air Pollution; a global assessment of exposure and burden of disease, WHO, Geneva.
4. SDG Metadata on indicator 3.9.1: mortality rate attributed to household and ambient air pollution.

1.3 Concepts for Prevention of Adverse Health, Safety and Environmental Impacts




Purpose:

To equip participants with knowledge and understanding of:

- The principles for prevention and harm minimization of the adverse impacts of household energy use on health, safety, the environment and climate.
- The importance of ensuring that advice on improved household energy choices is evidence-based.

Training objectives	By the end of this Unit, the participants should understand principles for the prevention of adverse effects of household energy use that: • Build on the Recommendations of the WHO Air Quality Guidelines for Household Fuel Combustion. • Include both 'radical' approaches to prevention (reducing emissions) and harm minimization (ventilation, smoke avoidance), and the relevance of both approaches. • Ensure that safety remains an important part of prevention efforts. • Take account of the needs and preferences of households, considering the consequences if this is not done. • Recognise the need to base advice on objective evidence about the performance of alternative fuel and device options.
Duration	 **90** mins
Methodology	Groupwork, facilitated discussion with questions and answers, exercises with sketches and photos.
Materials	Cards, marker pens, booklets, ballpoint, flipcharts, videos, journals, and pictures [photos].
Activity	Gaining familiarity with the principles of evidence-based prevention and harm minimization.

Facilitation Step 1.3.1: Recap of principles for preventing adverse health impacts

1. Recap on WHO Guidelines and concepts linking emissions, air pollution and exposure.
2. Facilitators can use the simplified list of the WHO Recommendations in Resource 1.3.1, and the simplified version of the concepts chart in Figure 1.3.1. The aim of this Unit is to ensure participants are familiar with the evidence-based approach to prevention and harm minimization.
3. Ensure understanding and answer questions.

Resource 1.3.1: Recap of main WHO recommendations and concepts of emissions, air pollution and exposure

WHO Guideline Recommendations (in brief)

1. Reduce emission rates

In order to secure health benefits, exposure requires to be reduced to low levels, requiring large reductions in emissions. In practice, the only certain way to achieve this is through clean fuels. Emission rates are proposed as a benchmark of what is required.

2. Policy during transition

Recognising that significant numbers of households in developing countries will not be able to make rapid and full transitions to clean fuels, it is recommended that 'intermediate step' (i.e. improved solid fuel stoves) delivering substantial health benefits should be prioritized. Standardized laboratory-based testing of pollutant emissions provides a means of assessing what health benefits can be expected.

3. Household use of coal

Coal, in particular unprocessed coal, should not be used as a household fuel, although as this fuel is rarely used in East Africa, this recommendation is not as relevant as the others.

4. Household use of kerosene

As a result of concerns about the health and safety risks of kerosene for cooking and lighting in the home, its use is discouraged.

Concepts of emissions, air pollution, and exposure

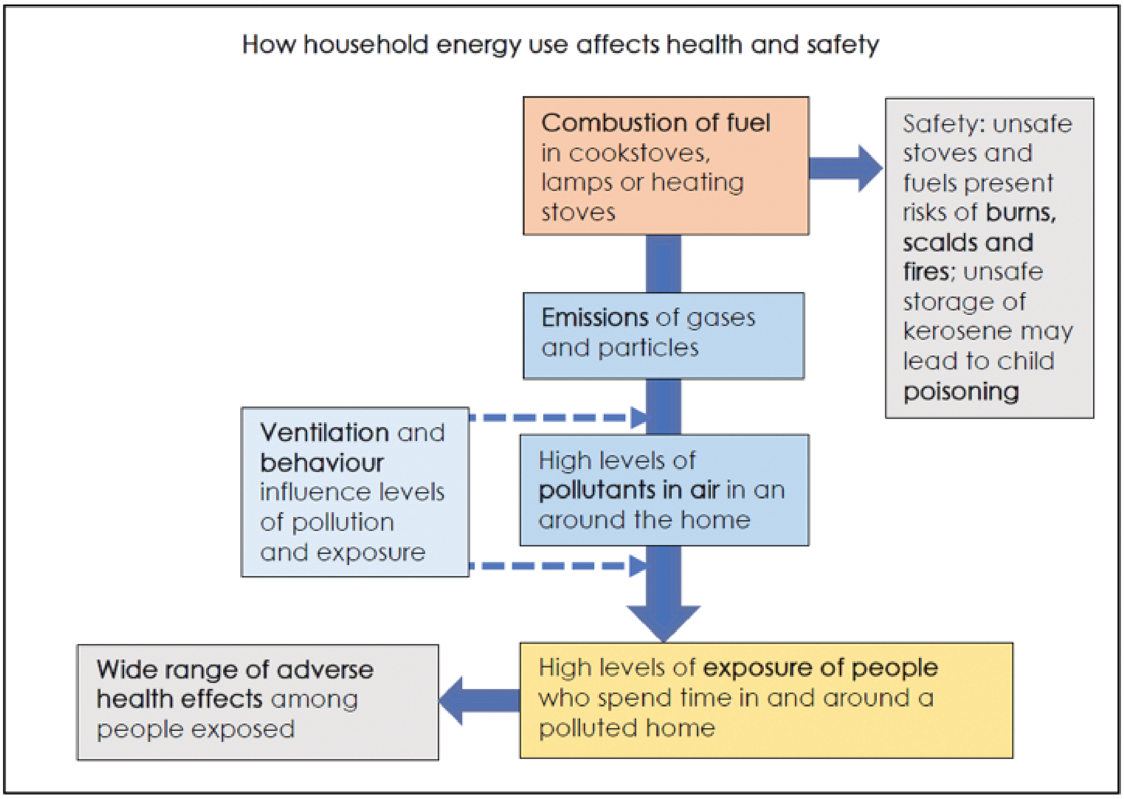


Figure 1.3.1: *A simplified version of the Figure introduced in Unit 1.2 (Figure 1.2.1) focusing on how combustion leads to pollution, exposure and adverse health effects, the potential effects of ventilation and exposure avoidance, and the risk of injury and poisoning.*

Facilitation Step 1.3.2: Reducing exposure in the home

1. Exercise 1.3.1: present the sketch of the **rural** home and ask groups to discuss how to reduce exposure. Participants should consider both 'radical' approaches (i.e. reducing emissions at source), and harm minimization.
2. Present and discuss the participants' responses, ensuring that they have considered effective emission reduction options where possible.
3. Exercise 1.3.2: present the sketch of the **urban** home and ask groups to discuss how to reduce exposure. Participants should consider both 'radical' approaches (i.e. reducing emissions at source), and harm minimization.
4. Present and discuss the participants' responses, ensuring that they have considered effective emission reduction options where possible.

Exercise 1.3.1: approaches to reducing exposure in a rural home

Exercise 1.3.1: approaches to reducing exposure in a rural home

In this rural home, cooking is done on a three-stone wood fire, and lighting is provided by a kerosene wick lamp. There is no electricity supply in the vicinity. How might you advise the family to reduce exposure to HAP?

Artwork © Plymouth University

Points for discussion:

There is no single 'right' answer as solutions will depend on the household's financial resources and what is available. Here are some ideas that can be considered:

1. If LPG is affordable and a reliable supply is available nearby, a change to cooking with this fuel should be encouraged along with advice on safe practices in usage and cylinder exchange.
2. It may well be that in a rural area, switching to exclusive cooking with a clean fuel such as LPG is not yet affordable and practical, so an improved stove might be proposed. This must have been tested at a certified laboratory such as KIRDI in Nairobi and meet minimum performance standards for efficiency, pollutant emissions, safety and durability (more on this in Unit 2.4).
3. If a solid fuel stove continues to be used, ventilation can be improved, and family members can try to avoid exposure where possible – these and other 'harm minimization' options are considered further in Unit 3.
4. For lighting, a solar (PV) charged lamp would be the best option; these are relatively cheap, have no running costs, and are safe.
5. Note that the man outside of the kitchen is smoking. Not only does this damage his own health, but it also contributes to the exposure of other members of the family. He should be encouraged to quit smoking.

Exercise 1.3.2: approaches to reducing exposure in an urban home

In this urban home, cooking is done on a charcoal jiko, and lighting is provided by a kerosene hurricane (non-pressurized) lamp. The electricity grid passes nearby but is not connected. The home is close to a busy road.

Artwork © Nigel Bruce

Points for discussion:

As with the rural home, there is no single 'right' answer as solutions will depend on the household's financial resources and what is available. Here are some ideas that can be considered:

1. LPG is likely to cost the same or less than charcoal, so a change to cooking with this fuel should be encouraged along with advice on safe practices in usage and cylinder exchange.
2. The household may find that changing from frequent small purchases of charcoal to less frequent but much larger expenditure on LPG cylinder refills difficult to manage. New 'pay-as-you-go' services are helping to overcome this, and home delivery may also be available.
3. For lighting, electric lighting would be the best option. If a connection to the grid is not possible to afford, a solar (PV) charged lamp could be used; as already noted, these are relatively cheap, have no running costs, and are safe.
4. In this illustration, only the woman cooking is visible, and she is not smoking. Enquiries could be made about other adults, and if there are smokers they should be encouraged to quit smoking.
5. The home is close to a busy road, so levels of outdoor air pollution from traffic may also be high. In an urban area such as this, it is likely that the family is also exposed to pollution from cooking and lighting sources in other nearby homes. These are not sources that the household has much direct control over, other than by re-location or encouraging others to use clean fuels. The local health and environmental authorities should monitor ambient (outdoor) air pollution and implement policy to reduce this.

Facilitation Step 1.3.3: Thinking about safety

1. Exercise 1.3.3: ask participants to read the two safety case studies.
2. Discuss the stories, using the Q&A provided.
3. Exercise 1.3.4: ask participants to read the stove stacking case study.
4. Discuss the story, using the Q&A provided.

Exercise 1.3.3: Safety case studies

Case study A: A new cookstove

At the local market, Mary got talking to a lady who was selling improved cookstoves. She had overheard the lady telling another woman about how the new stove could save quite a lot of wood and produced less smoke. Mary disliked the sore eyes and headaches she experienced most days from the smoke and was also worried that her young children played near her three-stone fire. A friend's child had recently had to go to the hospital for treatment of a burn from the cookstove. Mary decided to buy the new stove.

She was pleased with the stove and how efficient it was – now, instead of spending an hour or more each day collecting wood, she only needed to go two or at most three times per week and there seemed to be a bit less smoke when she was cooking. One day, a week or so later, Mary was just outside the kitchen washing dishes when she heard a scream. Rushing back inside, she saw her three-year-old daughter crying and holding up her hand. She had reached out at the stove and some burning wood had fallen out.

Case study B: Reducing exposure by keeping away from cook smoke

Jane had recently visited the local health centre for treatment of her cough, which she often had while cooking. Recently, this had been much more frequent, had kept her awake at night and she had felt weak and feverish. With a diagnosis of pneumonia, she had been prescribed an antibiotic and the nurse had encouraged her to keep away from the cooking smoke as much as possible.

A few days later, while cooking, she felt the coughing starting again. Her two-year-old son Paul was playing with his elder sister outside, so she went to the main part of the house to fold the laundry while the beans were cooking. A few minutes later she returned to the kitchen to check the meal and was horrified to see Paul reaching up to touch the pot of boiling water. She pulled him away and went outside, very frightened by what had happened; a few seconds later he would have been scalded all over and she knew he would have been badly burned.

Questions and answers:

1. What is the main learning from the first case study?
   - Changing the stove or other technology used to burn household fuel may result in greater efficiency and less emissions, but that does not mean it is necessarily also safer to use.
   - The safety of new technologies and fuels should be assessed, not assumed.

2. In the second case study, Jane had been unwell and was advised to keep away from the kitchen smoke, unwittingly putting her little boy at risk of a serious injury. What can we learn from this?
    - Some of the approaches available for harm minimization, such as avoiding exposure to pollution, do not change the inherent safety characteristics of the technology and fuel.
    - We should not overlook the consequences of recommended behaviour changes for the safety and supervision of young children.

Exercise 1.3.4: stove stacking case study

Jimiyu lives in a Cheptiret, a village near Eldoret. His family uses wood in a traditional mud stove for most of their cooking and occasionally some charcoal in a jiko. As a science teacher, Jimiyu has taken a growing interest in recent articles in the Daily Nation about the health risks from cook smoke and one evening talked to Rose, his wife, about getting an improved cookstove that was featured in one of the newspaper articles.

He had read that this type of stove was available in Eldoret, it looked well-made and with a price of KSh 22,000, they could just about afford it, and – according to the article – they might even save some money on wood fuel. The next Saturday, Jimiyu and Rose took the bus into Eldoret, saw and liked the look of the stove, brought it home, and installed it in the kitchen hut.

The following day, Jimiyu came home from work to find Rose upset. She liked the stove and said that it was easy to light, but she was struggling to prepare ugali which was difficult to cook on the new stove. She was worried there would be other dishes she could not cook to her and her family's satisfaction, and when family or guests came by at the weekend, she was sure it would be even more difficult to manage.

Rose continued to use the new stove as much as she could, as it was clear that it burned less wood. But for ugali, and for larger family gatherings, she also lit the traditional stove she had kept in the kitchen.

Jimiyu was concerned that now, instead of having just one stove in the kitchen, one that he had expected would be more efficient and cleaner, there were times when two were in use. Surely this would not be good for the family's health, and after spending from their limited income buying the improved stove, were they now making any savings at all on the cost of wood fuel?

Questions and answers:

1. What might have helped Jimiyu and Rose in choosing the best alternative cookstove for their needs?
    - Help and advice in assessing their needs and looking at various cleaner and more efficient options for meeting them
2. What is the term used to describe a situation where more than one energy technology and/or fuel is being used in the home to meet a need, such as cooking, or lighting?
    - This is commonly referred to as 'stacking'
3. What positive messages emerge from this story?
    - The fact that Jimiyu had taken an interest in HAP and health and read about it.
    - He then took the step of discussing his concerns with his wife, and together they decided to invest in a new stove.
4. What other messages can be interpreted in this story? There are several other messages that can be discussed, including:
    - Did the media (newspaper) give appropriate advice? If not, why was this? What might help ensure the media are informed about the best approach?

- Although Jimiyu's family is 'stacking', they have thought about the issues and taken some action, so further change is possible. But they will need encouragement, and good advice.

Facilitation Step 1.3.4: Ensuring interventions are effective and safe

1. Emphasize to participants that before encouraging a household to change the fuel, stove, or lighting, we must be sure that the alternatives we are proposing are as efficient, clean and safe as possible. In these next two exercises, we will start to look at how we can be sure about this.
2. Exercise 1.3.5: show the participants the photos of the two stoves and present the question. Discuss their responses using the answers given. Note that we will look at testing in **Unit 2.4**.
3. Present and re-enforce the **principles** for reducing the adverse impacts of household energy use in Resource 1.3.2.

Exercise 1.3.5: How do we know how effective alternatives stoves are?

Here are two cookstoves, on the left an improved biomass stove (Envirofit) and on the right an LPG stove:

Photos © Nigel Bruce

Both are in use and look clean enough, but how do we know what they are really like?

- LPG is known to be a very clean-burning fuel, and this clean-burning performance varies little according to setting and conditions.

- Biomass stoves are not as clean-burning, and their performance is more variable; standardized testing provides the only reliable way of determining the level of pollutant emissions from a solid fuel cookstove.

Testing is also be used to assess efficiency, safety, and durability. We will look at this next with the ISO test protocol and performance targets in **Unit 2.4.**

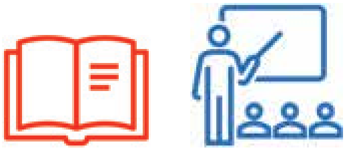
Resource 1.3.2: Principles for protecting health against the harmful effects of household energy use

- The best way to reduce adverse health effects from HAP is to reduce emissions at the source to very low levels - and that means using cleaner fuels such as gas and/or electricity.
- If using clean fuels is not practical or affordable, we can use solid-fuel stoves that reach specified levels of efficiency and emissions performance in standardized testing.
- It is important to dry solid fuel such as wood before use, as it then burns more cleanly with lower emissions.
- Improving the ventilation in a home using a chimney, open windows or vents, can help to reduce the concentration of pollution indoors.
- Spending less time in a polluted area can help to reduce exposure to household air pollution.
- We must not assume that a new or 'improved' stove or fuel, or behaviour change, is necessarily safe – safety should be assessed, and advice given on safety practices.
- Remember that emissions from combustion in the home contribute to outdoor ('ambient') air pollution, and to impacts on the climate.

UNIT 2

Health and Safety Impacts of Household Energy Use

2.1 Health Impacts of Household Air Pollution



Purpose:

To equip participants with knowledge and understanding of:

- The health symptoms experienced by people exposed to household air pollution.
- The serious short-term and longer-term health impacts, including respiratory, circulatory, cancer, eye disease, and adverse pregnancy outcomes.
- The mechanisms by which HAP causes ill-health.
- The burden of disease caused by HAP.

Training objectives	By the end of this Unit, the participant should be able to: • Describe the symptoms experienced by people exposed to HAP. • Describe the major disease conditions caused by HAP exposure. • Show awareness of other disease conditions which may be caused by HAP exposure. • Show a basic understanding of the mechanisms by which HAP exposure affects the lungs, other organs of the body, and the unborn child. • Show awareness of the ‘Burden of Disease’ (deaths and ill-health) caused by HAP globally, regionally (Africa), and nationally (Kenya).
Duration	 **90** mins
Methodology	Video, case study, mini lecture and facilitated discussion.
Materials	LCD projector and laptop, video, flipcharts and marker pens.
Activities	Instruction and groupwork on specific symptoms and diseases, mechanisms by which HAP causes disease and burden of disease.

Facilitation Step 2.1.1: Symptoms and diseases caused by HAP

1. Show video (Video 2.1.1: duration [90] seconds) of cooking on a wood cookstove in a home in Langas, Uasin Gishu.
2. Ask groups to discuss and record (flipchart) what (a) symptoms and (b) disease conditions are experienced by people exposed to smoke in and around the home.
3. Harmonize the responses and use Table 2.1.1 (in Resource 2.1.1) to demonstrate and discuss the full list of symptoms and diseases.
4. In Table 2.1.1, highlight those diseases for which here is strong evidence of causation, and other disease conditions for which there is suggestive evidence.

Video 2.1.1: Exposure to HAP while cooking

Resource 2.1.1: Symptoms and disease conditions linked to HAP exposure:

Those exposed to high levels of HAP as they go about their daily lives may not be aware of the serious consequences for their health and that of their children. Of course, raising awareness of these consequences will now be one of the most important tasks of this community health worker training initiative.

But people exposed to smoke are generally very aware of symptoms of irritation from smoke. Some of these symptoms, such as cough, may of course also be the result of a serious disease that has taken hold.

In general, we can say that HAP results in most of the same diseases and problems as **tobacco smoking**, although without the nicotine addiction.

There have been far fewer studies of health risks from HAP compared to the huge amount for tobacco smoking. So, while we have good evidence that HAP exposure **causes** some important diseases, there is only **suggestive evidence** for others. In time, we can expect the evidence for these other conditions to be strengthened.

In any case, there is already **ample evidence** of the very serious consequences for health of exposure to HAP over the life course, from effects on the unborn child, right through to old age.

Further information:

A detailed review of the evidence linking HAP exposure to disease outcomes is available as part of the WHO Indoor Air Quality Guidelines for Household Fuel Combustion (2014), available at:
https://www.who.int/airpollution/household/guidelines/Review_4.pdf?ua=1

Table 2.1.1: *Symptoms and diseases linked to HAP exposure*

Health impacts		Specific symptoms and disease conditions
Symptoms	A 'symptom' is a pain or discomfort experienced by a person as a result of illness or injury	• Sore and running eyes • Headache • Cough and phlegm production • Tiredness and drowsiness, also unconsciousness and convulsions with severe CO poisoning)

Health impacts		Specific symptoms and disease conditions
Disease conditions	Major disease conditions that are **caused** by HAP and included in the 'Burden of Disease' calculations	• Pneumonia in children • Chronic Obstructive Pulmonary Disease (COPD) • Ischaemic heart disease • Stroke • Lung cancer • Eye cataract (females)
	Other important disease conditions that are **caused** by HAP exposure but not included in the 'Burden of Disease' calculations	• Reduced birth weight • Pre-term delivery • Cancer of the upper aero-digestive tract • Pneumonia in adults • Fluorosis and Arsenic poisoning where **coal** contains these contaminants
	Disease conditions for which there is **suggestive evidence** of a causal link with HAP exposure and requiring more research evidence.	• Asthma exacerbations • Tuberculosis • Restrictive (fibrotic) lung disease • Diabetes Mellitus • Cognitive impairment in young children • Eye cataract (males)

Facilitation Step 2.1.2: A child with pneumonia

1. Exercise 2.1.1: case study based on the story 'Family burden of child pneumonia'.
2. Facilitate discussion of the story based on the points in the Commentary.
3. Re-enforce learning from this story: while we want to be pro-active with prevention and not wait until children or adults become unwell or die, we can relate experience of illness to motivation for change in the same way that we might for WASH following episodes of diarrhoea.

Exercise 2.1.1: Family burden of child pneumonia

Only a few weeks ago, Lucy [name] had brought Emmanuel - her new baby boy – home from the hospital. He was her second child, and while he had been born healthy, he was a little underweight. He fed well though, and all seemed well back at home in their village, some 30 km north of Kisumu, where like most families, she did all her cooking on a traditional wood cookstove in a kitchen hut and kept the baby on her back while cooking.

When he was four weeks old, Emmanuel stopped feeding and became drowsy. Lucy noted he was breathing very quickly, so when John, the local Community Health Volunteer called by, she asked him to look at the baby. John thought the child had pneumonia and told Lucy she must take Emmanuel to the local clinic as soon as she could. Once at the clinic, which was only ten minutes' walk away, the doctor examined the baby, confirmed a diagnosis of pneumonia, and prescribed a course of antibiotic.

Emmanuel recovered over the next few days and all seemed well. But, just a few weeks later, he fell ill again with similar symptoms, although he was coughing more. Lucy took him to the clinic, where the doctor seemed very concerned.

"Emmanuel is very sick with pneumonia", he said to Lucy; "it will not be wise to treat him at home as we did last time, he needs to go to the hospital for treatment with oxygen - see his lips are blue, he cannot breathe properly".

The hospital was 30 km away, and Lucy had another young child to care for. Her mother lived nearby and although old and unwell herself could probably help. Her husband had found work in Nairobi, and although he returned home at the weekends, it was only Tuesday. Worried about the cost and her family, Lucy nevertheless knew she had to do as the doctor advised and went home to make arrangements.

Emmanuel did recover in the hospital, but had to stay there for ten days, which was a great burden to Lucy and her family. When she returned to the clinic for a follow-up appointment, she was told Emmanuel had recovered, but she wanted to know why he had already fallen ill with pneumonia twice.

Commentary:

Here are some points to use with the facilitated discussion, and to answer participants' questions:

1. Pneumonia is one of the most common serious illnesses of young children, although the pneumococcal vaccine is helping to reduce the incidence of this.
2. Although multiple factors can increase the risk of a child contracting pneumonia, in this story, there are a couple of risk factors we should note.
   a. He was born with a low birth weight, which we have already seen is linked to HAP exposure of the pregnant mother-to-be.
   b. His mother cooked with a traditional wood stove and carried the baby on her back, so he would have been exposed to high levels of HAP.
3. We cannot know for sure that exposure to HAP caused Emmanuel to have a low birth weight, nor that it caused his pneumonia, but we can say that it is likely HAP increased the risk of these outcomes.
4. Quite apart from her own health and that of her husband and mother, with two young children, and perhaps more to follow, reducing HAP in and around Lucy's home is now a priority.

Facilitation Step 2.1.3: Mechanisms by which HAP causes ill-health

1. Present key information on mechanisms based on Resource 2.1.2, starting with Figure 2.1.1, the picture comparing lungs that have, and have not, been exposed to smoke.
2. Cover mechanisms relating to lung disease, diseases of other organs, and adverse pregnancy outcomes (Figure 2.1.2).
3. Mention acute CO poisoning briefly, and that we will cover this in Unit 2.2.
4. Ensure there is understanding of the main points and answer questions.

Resource 2.1.2: Resource on mechanisms by which HAP causes disease

Diseases of the lungs:

Since smoke is easily breathed in, it is hardly surprising that lung disease is one of the commonest consequences of exposure to HAP.

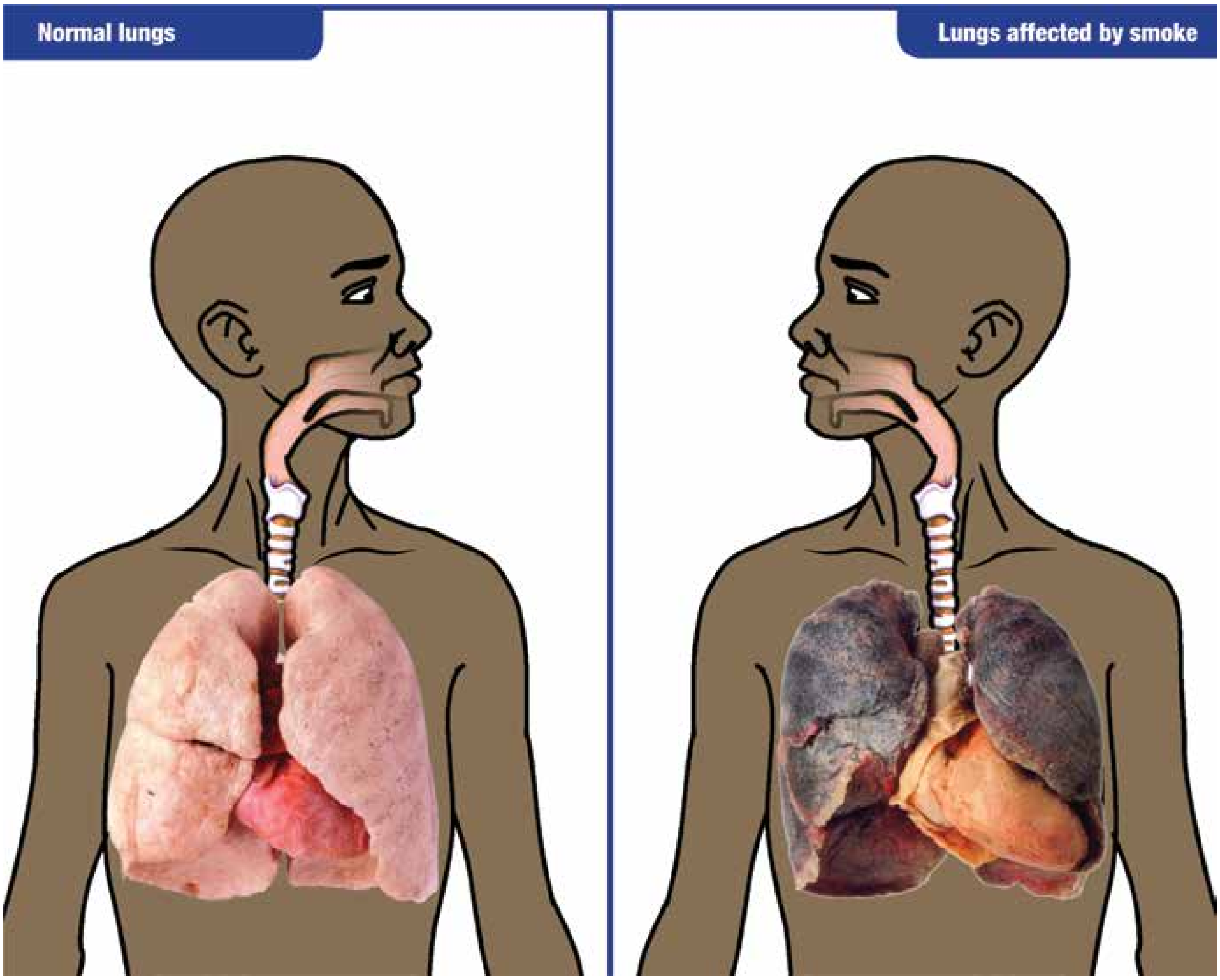
In Unit 1.2, we discussed particulate matter (PM), and noted that it comes in various sizes, from very fine (invisible to the naked eye) to large dust (visible to the naked eye). Most of the PM emitted by the combustion of wood, other biomass, and kerosene in the home, is very small (we called this $PM_{2.5}$ as the average diameter is 2.5 micrometres - µ).

When these very small particles are breathed in, they reach deep into the lung. This means that the whole of the lung is at risk. Once in the lung, the pollution irritates the tissues and impairs the lung's natural defences. The results are:

- Resistance to infection (pneumonia) is reduced;
- A process of chronic (long-term) damage to the structure and functioning of the lung is started, known as chronic obstructive pulmonary disease (COPD);
- Those susceptible to asthma may experience exacerbations (asthma attacks).

Lungs that have been exposed to smoke pollution for many years are, as is the case with tobacco smokers, quite blackened. Figure 2.1.1 compares the appearance of a lung (on the left) that has not been exposed to years of smoke, and one (on the right) that has.

Figure 2.1.1: *Comparison of lungs exposed and not exposed to smoke*



Ministry of Health, Uganda

Smoke from burning wood, coal and kerosene also contain substances such as polyaromatic hydrocarbons (PAHs) that are known to cause cancer. So, people exposed to HAP for many years are also at increased risk of developing lung cancer, even if they do not smoke tobacco.

Of course, if they also smoke, or live in a home where others smoke (passive smoking), then the risk of lung (and other cancers) is even higher

Diseases of other organs in the body:

We noted that most of the PM in HAP is very small and can get into all areas of the lung. Actually, the situation is even worse than that. Some of the particles are so small that they pass through the lungs and into the circulation and are then pumped by the heart to all organs of the body. The cardiovascular system is at particular risk: HAP exposure causes heart disease and stroke. Cataract (blindness) is thought to be caused by the pollutants passing through the bloodstream to the eyes.

This is why exposure to air pollution, in general, is such a large public health problem around the world as it causes a wide range of serious disease conditions.

Adverse pregnancy outcomes:

Exposure of the pregnant woman to HAP is a concern because the development of the fetus is very critical and known to be sensitive to many chemicals.

Most pregnant women continue with their work in the kitchen and around the home during pregnancy. So, they are exposed from before conception, through the earliest stages of fetal development in the first trimester, to the main period of growth of the fetus during the later trimesters.

The chemicals in smoke pollution also cross the placenta. In addition to the various pollutants in the particles, gases such as carbon monoxide (CO) also affect the fetus. CO binds to the oxygen-carrying protein in the blood (Haemoglobin) and reduces its ability to deliver oxygen to the tissues and organs, including the fetus. This is thought to be one of the most important mechanisms by which HAP affects birth weight, and probably pre-term birth (although other chemicals including PAHs are likely also involved).

In the picture below, a new mother is distressed to see that her baby is small, and (perhaps) also pre-term. Low birth weight and prematurity make the baby more vulnerable to a wide range of health and developmental problems.

Figure 2.1.2: *A mother shows her concern that her baby is small.*

Ministry of Health, Uganda

Carbon monoxide (CO) poisoning:

Short-term exposure over periods of minutes or hours to high or very high concentrations of carbon monoxide causes toxicity which can be fatal. This is dealt with in Unit 2.2 (Safety).

Facilitation Step 2.1.4: Burden of disease from HAP

1. Present key information on the Burden of Disease from HAP using the map (death rates for all countries), the graph (death rates for regions – highlight Africa) and the table (number of deaths by cause and sex, Kenya).
2. Facilitate discussion based on the Commentary points.
3. Ensure there is understanding of the main points and answer questions.

Resource 2.1.3: Global, regional and national burden of disease from HAP

Note to Trainers:

It is important that **trainers** are familiar with the information in this resource. For **trainees**, it is sufficient for them to be aware of the number of deaths globally, regionally, and for Kenya.

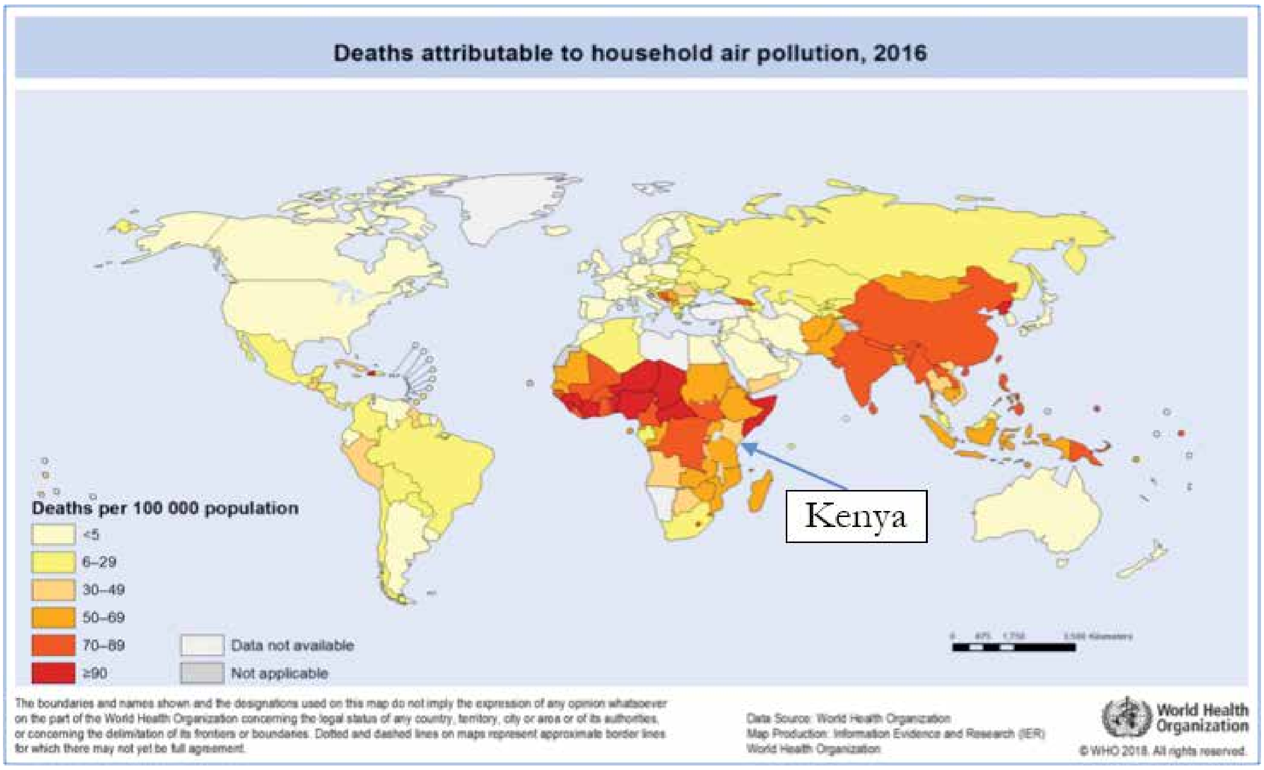
The global disease burden:

The WHO Indoor Air Quality Guidelines for Household Fuel Combustion (2018), introduced in Module 1.1, were developed to address the very large burden of disease that is caused by HAP.

We will not go into the methods for determining the burden of disease from HAP in any detail, but in essence, this is done by combining information on three components of the problem, some of which you are now familiar with:

- The numbers of people exposed to HAP and the levels of $PM_{2.5}$ they experience;
- The risk of various diseases from this exposure, for which there is *causal* evidence;
- The underlying rates of these diseases in the population.

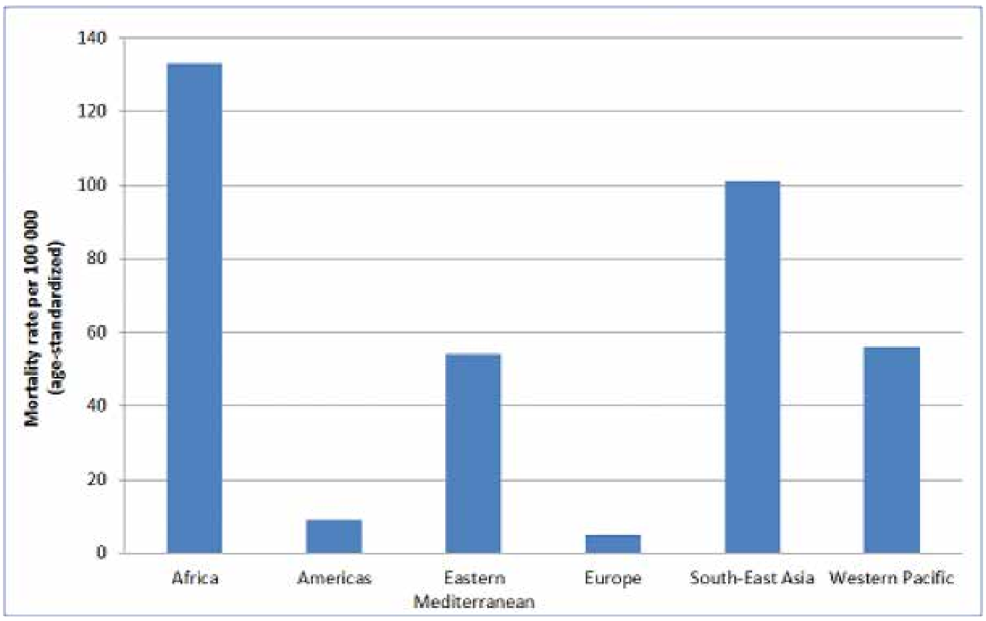
In 2016, household air pollution was responsible for 3.8 million deaths, amounting to 7.7% of the global mortality. Look at the map below – it is clear that the disease burden mirrors closely the prevalence of polluting fuels (solid fuels and kerosene) use for cooking:



Source: http://gamapserver.who.int/mapLibrary/Files/Maps/Global_hap_deaths_2016.png

Regional disease burden:

The following graph shows death rates per 100,000 population due to HAP for 2016, showing that the African region is the worst affected **per head of population:**



Source: WHO

Kenya:

The table below shows the WHO estimates for premature deaths resulting from HAP exposure in 2016 in Kenya, by cause, and for males and females:

Disease	Males	Females	Total
Lower respiratory infections	5125	4957	10083
Cancer of the trachea, bronchus and lung	126	103	229
Ischaemic heart disease	997	957	1954
Stroke	790	1020	1810
Chronic Obstructive Pulmonary Disease	484	580	1064
Total	**7523**	**7617**	**15140**

Source: http://apps.who.int/gho/data/node.main.BODHOUSEHOLDAIRDTHS?lang=en

All such calculations come with some **uncertainty**. For example, WHO provides uncertainty intervals around the totals of 6150 to 8765 for the males' total (7523), and of 6353 to 8630 for the women's total (7617). So, although there is inevitably some uncertainty about the exact numbers, these figures give a good idea of the range. These burden of disease estimates are updated from time to time. The latest figures, produced by the Institute of Health Metric and Evaluation (IHME 2020) indicate that more than 22,000 Kenyans died prematurely from exposure to HAP in 2019. This increase over the WHO figure will be due to some differences in methods and to population increase.

Commentary for discussion led by the Facilitator:

1. Do these numbers surprise you? Are they more or less than you would have expected?
2. It is often helpful to have a comparison: for 2016, WHO estimated that there was a total of 24,790 premature deaths attributable to deficiencies in water, sanitation, and hygiene.
3. It is important also to keep in mind that for every premature death from these diseases, many more people suffer a non-fatal illness which may last for many years. In addition to the pain and discomfort, they may be unable or less able to work, with financial implications for their families dealing with the loss of income and health care expenses.

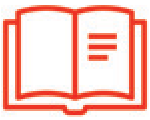
Individual and population risk

What about the comparison between males and females? If women are more heavily exposed in the home than men, why are the numbers of deaths almost equal? Trainers should be aware of the issues behind this observation, as they may be called upon to explain this with colleagues, community health workers, or the media. There are two main reasons why the numbers of deaths for males and females are similar in the case of Kenya (and similar countries):

a) Most of the deaths are due to acute lower respiratory infections in young children under 5 years of age. At these ages, boys and girls are more-or-less equally exposed and the sex ratio (total numbers of boys and girls) in the population is approximately equal. So, we would expect the numbers of deaths to be very similar.

b) It was explained above that, in calculating the burden of disease, the HAP-related risks of a specific disease (which are lower in men than women due to their lower levels of exposure) are applied to underlying rates of that disease in the country. Most of the 'adult' disease conditions, e.g. IHD and COPD, are more common in men than women, so the net result is that the numbers of deaths for the 'adult' diseases are similar for men and women.

2.2 Recognising and Minimizing Safety Risks from Household Energy Use




Purpose:

To equip participants with knowledge and understanding of:

- The main risks to safety arising from the use of household energy.
- Risk factors for safety-related injuries and deaths, and implications for prevention.

Training objectives	By the end of this Unit, the participant should be able to: • Recognize the main safety hazards arising from the use of energy in the home for cooking, lighting, heating, and other applications. • Recognise that the safety of new fuel and/or technology adopted by a household should not be assumed; it should be assessed. • Describe the frequency, severity of injury, and consequences that these safety hazards can lead to. • Be aware of risk factors for burns in the national (Kenyan) context, and the implications for prevention. • Define key terms relating to household energy and safety.
Duration	 **90** mins
Methodology	Story, photographs, mini lecture and facilitated discussion.
Materials	LCD projector and laptop, flipcharts and marker pens.
Activity	Circumstances and causes if burns to inform prevention, frequency and consequences of injuries.

Facilitation Step 2.2.1: Carbon monoxide poisoning

1. Exercise 2.2.1: Participants read and discuss the story about carbon monoxide poisoning and make notes on key issues that could inform prevention.
2. Groups report back and facilitate discussion based on the Commentary points.

Exercise 2.2.1: A tragedy caused by carbon monoxide poisoning

This story is about a young mother who used to live in a slum called Mukuru kwa Reuben in Nairobi. Her home, like other homes in this slum, was a single room constructed out of corrugated iron sheets. She had a small baby. She cooked in the same room using a charcoal jiko.

One day, while she was cooking, she decided to run a short errand. The baby was resting peacefully on the bed. It is not safe to leave the door or windows open when leaving a slum home – so she locked both as she left. When she came back, she found that her baby had died. It was a terrible tragedy. She did not really understand why the baby had died – but perhaps it was God's will.

Sometime later, she gave birth to another baby. She was still living in the same home. Once again, she needed to run a quick errand. She was cooking and the baby lay comfortable on the bed. She locked the window and the door and left. On returning, she found that her second baby had also died. It was an unbearable tragedy.

As is the case, she had to inform the authorities about the death, just as she had done with the death of the first child. This time the health officials told her clearly that her children had died from carbon monoxide poisoning. This poisonous gas was produced by the jiko (partial combustion of the charcoal under poor ventilation). The young mother was understandably very upset. She moved from Nairobi and returned to her home in Western Kenya.

Commentary:

1. While the death of the first child was based on the mother's ignorance, the second death could have been avoided.
2. The health clinic (including the area chief) should have communicated clearly to this mother the dangers of using a charcoal stove in an enclosed room and the dire consequences of carbon monoxide poisoning.
3. This advice may have helped her protect the second baby.
4. A more reliable means of prevention would be for the family to change to a cooking fuel that does not emit dangerous levels of carbon monoxide – for example, LPG.

Facilitation Step 2.2.2: Safety issues with household energy

1. Exercise 2.2.2: Show each photo (with the heading) of the safety risks, in turn, allowing sufficient time (a few minutes) for each to be discussed and notes made by the groups. The headings/photos are:
   a. Burns from hot solid fuel
   b. Scalding from hot fluids
   c. Fires
   d. Explosions
   e. Poisoning by carbon monoxide
   f. Poisoning by kerosene ingestion
   g. Electrical burns and electrocution
2. Groups report back, then facilitate discussion based on the Commentary points.
3. Inform participants that the ISO testing protocol covers the safety of cookstoves, which we will look at again in Unit 2.4.

Exercise 2.2.2: Safety issues for household energy

Safety issue	Situations in which these arise and pointers for prevention
Burns from hot solid fuel	**Commentary:** • Any household energy device that burns solid fuel can, in principle, be the cause of burns to children and adults from the hot fuel if this falls out of the fire, or the person touches the fuel or falls onto the fire. • Clothes such as long dresses are also at risk of catching fire in these circumstances. • Some stove/fuel combinations present a higher risk than others, especially those which have an open combustion chamber on the floor that young children can easily reach. • It should not be assumed that just because the stove appears to contain the hot fuel, that it is necessarily safe from this point of view.  © Nigel Bruce *Open fire cookstove in a rural home.*

Safety issue	Situations in which these arise and pointers for prevention

Scalding from hot fluids

Commentary:

© Don O'Neill

Child with badly burned/scalded hand.

- The greatest risk of scalding, especially of children, is when a pot with hot water or other liquid or semi-liquid food is knocked over.
- This is most likely to happen if the pot/stove combination is not stable and/or children are not adequately supervised when cooking is underway.
- Scalding in this way can in principle occur with any stove fuel/technology, although stoves that are placed on an elevated surface such as a table (i.e. typically gas (LPG, biogas), electric or ethanol stoves) may be less likely to within reach of young children.

Fires

Commentary:

Fire in a Nairobi slum: https://citizentv.co.ke/news/huge-fire-razes-down-200-houses-in-mathare-117755/

- Any stove/fuel can in principle start fires that spread to the fabric of the home. Closely packed housing, as in urban slums, are at risk of widespread fires.
- Kerosene stoves and lamps are one of the most important causes of fires; typical these start when the fuel is spilled, or the device knocked over while alight.
- Another cause is damaged or poorly fitted electrical wiring.

Explosions

Commentary:

© Nigel Bruce

Cooking with LPG is safe with regular maintenance of bottles and equipment.

- Fires and explosions caused by faulty LPG equipment do occur.
- Such events tend to feature in the media and in public awareness.
- LPG use is very safe when the market is correctly organized (that is, bottles are owned by the marketer and users swap the bottle for a full one so the empty one can be checked) and regulated (those supplying LPG follow the rules).
- Households also need to be aware of safe usage procedures, and what to do if they detect a leak; to help with this, a strongly smelling 'odorant' is added so leaks are easily detected.
- Prospective users may need to be reassured about safety, alongside the education on correct use, as fears about LPG accidents can be widespread.
- Facilitators should discuss perceptions (including their own) of fear of LPG explosions with participants and ensure there is a good understanding of what factors ensure safe LPG use.

Safety issue	Situations in which these arise and pointers for prevention

Poisoning by Carbon monoxide

Commentary:

© Nigel Bruce

Charcoal stoves are an important source of carbon monoxide emission.

- This was the topic of our story about the mother who lost two babies.
- Charcoal tends to produce more CO than fuels such as wood and is the main cause of CO poisoning, especially when used in an enclosed space e.g. for heating.
- The poisoning occurs when people are exposed to high concentrations of CO for relatively short periods of time, usually a few hours and up to a day or so.
- Milder or initial effects are drowsiness and headache, but with longer duration of exposure, or exposure to higher concentrations, this progresses to unconsciousness, convulsions, and death.
- Recall that the ISO testing includes CO emissions, and the targets (tiers) take into account potential CO poisoning, as well as the health risks for long-term lower dose exposure.

Poisoning by kerosene ingestion

Commentary:

© Nigel Bruce

Sale of kerosene in coke, etc., bottles in Nairobi.

- The typically occurs when children accidentally drink kerosene fuel.
- The practice of selling and storing kerosene in soft drink bottles increases risk.
- Most cases occur in children under 5 years of age and are probably more common than is generally recognized.
- The main threat to health comes from aspiration of kerosene into the lungs, which causes irritation (chemical pneumonitis) which can be fatal.
- Kerosene, where still used, should be stored in child-resistant containers.

Electrical burns and electrocution

Commentary:

© Jessica Lewis

Electric cooker.

- Contact with mains voltage power at 240 volts can cause burns and death (known as electrocution).
- Electrical injury is most likely to occur due to faulty or damaged wiring and equipment, including the practice of obtaining power illegally from passing power lines.
- Solar-powered equipment such as lighting runs at very much lower voltages (unless the power is from a local mini-grid providing 240 volts) and does not present any risk of injury.

Facilitation Step 2.2.3: Global and local data on burns

1. Present and discuss the global data and information from Resource 2.2.1 (section on global data), describing deaths and non-fatal burns.
2. Exercise 2.2.3: show participants the summaries of the two studies of burns seen in Kenyatta National Hospital, Nairobi. They should then discuss, make notes and report their ideas on how these burns could be prevented. Facilitate discussion of the responses, using the Commentary points provided.
3. Present the Definitions in Resource 2.2.2, ensure understanding and answer questions.

Resource 2.2.1: Frequency and risk factors for burn injuries

Global data:

According to the WHO, there are 180,000 deaths from burns each year, the vast majority in low- and middle-income countries. The majority occur in the home (especially women and children) and the workplace (especially men).

Non-fatal burns (numbers of which are at least ten times the fatal cases) are a leading cause of morbidity – that is, long term disability (including due to stigma), discomfort and pain – and negative socio-economic consequences.

Exercise 2.2.3: Kenya: Studies of burns seen at Kenyatta National Hospital, Nairobi

Joseph Wanjeri and colleagues have reported two studies of burns seen at Kenyatta National Hospital in Nairobi.

Risk factors for burns

The first study, designed to examine risk factors, involved 202 cases admitted with burns and 202 age and sex-matched controls admitted onto paediatric and medical wards and who did not have burns. Key findings were:

- Burns were most common among children aged 0-4 years (42.6%) and in adults aged 20-39 years (38.6%).
- The sex ratio was 1:1.
- The great majority of burns happened in the home (80.9%), with an additional 3% in a neighbour's or friend's home. A further 7.5% occurred at work, and 4% at the roadside.
- Factors associated with an increased risk of burns were a low level of education, use of kerosene as a cooking fuel, lack of knowledge about burn injury preventions and fire safety, and a family history of a prior admission for burn injury among family members.

Reference: Joseph K. Wanjeri, Mary Kinoti, and Tom H. A. M. Olewe. Risk factors for burn injuries and fire safety awareness among patients hospitalized at a public hospital in Nairobi, Kenya: A case control study. https://doi.org/10.1016/j.burns.2017.11.007

Factors predisposing to kerosene explosions

The second study involved 48 patients with burns resulting from kerosene explosions and was designed to study factors predisposing to these injuries. Key findings were:

- Mean age was 23.6 years
- The female to male ratio was 7:3
- Patients tended to be from poor or lower-middle socio-economic groups
- Most of the explosions occurred during cooking when the cooker was being refilled with kerosene
- The great majority (98%) involved kerosene stoves with wicks

Reference: Alex N. Ombati, Peter L. W. Ndaguatha, and Joseph K. Wanjeri. Risk factors for kerosene stove explosion burns seen at Kenyatta National Hospital in Kenya. https://doi.org/10.1016/j.burns.2012.07.008

Commentary on burns studies:

1. The use of kerosene as a cooking fuel is identified as an important risk. The WHO Guidelines (Unit 1.1) recommendations discourage the use of kerosene in the home, partly for this reason.
2. In terms of demography, young children and adults aged 20-40 years, the majority of women, are at greatest risk. This is not surprising given the roles of women in the home, and the fact the pre-school age children are around the home and in the kitchen much of the time. These are therefore the most important demographic groups to focus on for burns prevention.
3. The studies highlight the importance of poverty and lower levels of education, identifying groups as greater risk. These findings may represent poorer quality housing, crowding, and greater reliance on kerosene fuel, and local studies and data may be needed to establish the most important reasons for the higher risk in these groups.
4. The great majority of burns occurred in the home, as has been identified by WHO more generally. The home is therefore a crucial focus for burns prevention, whether through changing to safer fuels and technologies, or through education, or both.
5. One study identified lack of knowledge about burns prevention, which could be part of a targeted intervention.
6. The fact that most kerosene explosions occurred with wick stoves and during refilling (presumably while the stove was still alight) provides further specific information to target prevention through education and alternative fuels and technologies.
7. Burns patients were found to have more family members who had been admitted with burns injuries, suggesting that they live in an environment with a higher risk of burns.

Resource 2.2.2: Definitions relating to injuries from household energy use

Physical injury also known as physical trauma, is damage to the body caused by an external force, which may include a sharp object, or any object that is moving with sufficient force.

Burn is a type of injury to the skin, or other tissues, caused by heat, cold, electricity, chemicals, friction, or radiation. Most burns are due to heat from hot liquids, solids, or fire. Burns that affect only the superficial skin layers are known as superficial or first-degree burns, those that cause damage to deeper layers of skin, muscle, and other tissues (and result in scarring and contractures), are called second, or third-degree, burns.

Scald is a type of burn, caused by hot liquids or steam.

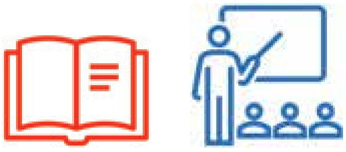
Poisoning is when cells are injured or destroyed by the inhalation, ingestion, injection, or absorption of a toxic substance. Key factors that predict the severity and outcome of poisoning are the nature, dose, formulation, and route of exposure of the poison; age and pre-existing health conditions [WHO].

Electrical burns and electrocution: The passage of a sufficiently powerful electric current through all or part of the body can cause injury through burns. If the shock is sufficiently powerful, this may cause death (electrocution) usually by stopping the heart.

Further reading:

1. WHO Factsheet on burns: https://www.who.int/news-room/fact-sheets/detail/burns
2. WHO/UNICEF Factsheet on child poisoning (not specific to kerosene): https://www.who.int/violence_injury_prevention/child/injury/world_report/Poisoning_english.pdf

2.3 Vulnerable Groups and Socio-Economic Impacts



Purpose:

To equip participants with knowledge and understanding of:

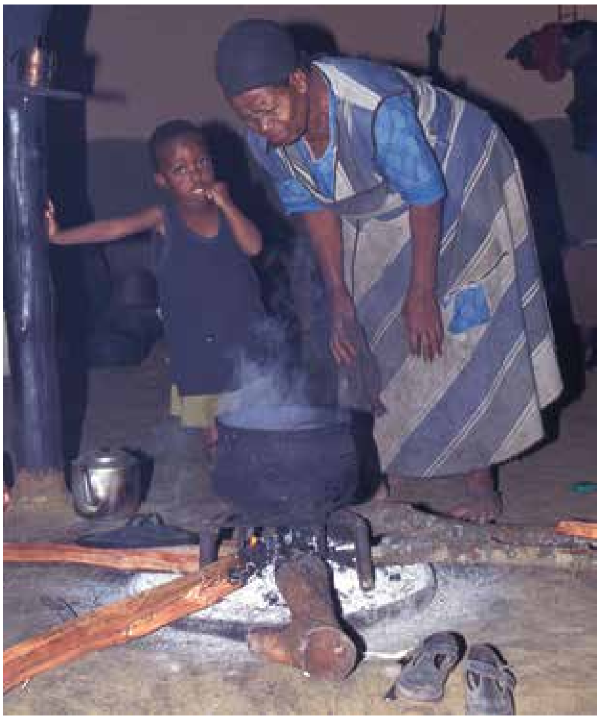
- The various social and economic implications of household energy supply and use, with a focus on women and children given domestic roles, to help inform prevention and harm minimization strategies (Unit-3).
- Those demographic groups at increased risk of negative health impacts from exposure to household air pollution.

Training objectives	By the end of this Unit, the participant should be able to: • Identify demographic groups, e.g. women and children, who experience the highest levels of exposure by virtue of their roles and activities in and around the home. • Identify those who are most susceptible to the negative health impacts from exposure, e.g. pregnant women, children, the elderly, and those with pre-existing disease. • Describe how social and economic impacts of traditional household energy supply and use, e.g. time involved in fuel collection and use of inefficient cooking and lighting technologies, affects the lives and opportunities of women and children in particular.
Duration	 **60** mins
Methodology	Groupwork and exercises, mini lecture and facilitated discussion.
Materials	LCD projector and laptop, flipcharts and marker pens.
Activity	Identify groups with (a) highest exposures to HAP and (b) those most susceptible to the negative health impacts of exposure to HAP and consider implications for prevention. Become more aware of the ways in which traditional household energy use impacts on lives and opportunities, especially for women and children.

Facilitation Step 2.3.1: Groups with higher exposure to HAP

1. Ask the participants to list demographic groups with the highest exposure to HAP.
2. Present and harmonize responses.
3. Lead a facilitated discussion of the implications for minimizing the adverse health impacts from exposure in these groups, drawing on Resource 2.3.1.

Resource 2.3.1: Demographic and socially-defined groups with the highest exposure to HAP



Women and young children generally experience higher levels of smoke pollution, and for longer periods, than other members of a household. This is because women do most of the cooking, childcare and other tasks around the home.

The groups most affected by HAP and other adverse impacts of household energy use are:

- Poorer and/or more rural people in general who are more dependent on polluting fuels and technology, and associated safety risks, such as burns including from kerosene wick stove (Unit 2.2).
- Women and others primarily responsible for cooking.
- Children, including babies, infants and very young children carried by or kept close to their mothers, and older children who may be helping with cooking, domestic chores, playing, or supervising younger siblings in and close to the home.
- Kitchen helpers, including in institutions (schools, hospitals, etc.).
- Those who are elderly and/or unwell and spend time at home in the kitchen, especially where they are wanting the warmth from the stove.
- Secondary schoolchildren and college students who, in addition to being exposed to smoke from cookstoves at home, may use polluting kerosene tin or unpressurised wick lamps for studying.
- Indigent groups including refugees.

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The most commonly used lamp in rural areas, the kerosene tin lamp, is not only very polluting but also provides poor quality lighting. This may be the only lighting source, perhaps along with candles, for women to work (e.g. needlework) and school children and students to study after daylight hours.

Facilitation Step 2.3.2: Vulnerable people

1. Ask the participants to list groups who are most vulnerable to the negative health impacts from exposure to HAP.
2. Present and harmonize responses.
3. Lead a facilitated discussion of the implications for minimizing the adverse health impacts from exposure in these people, drawing on Resource 2.3.2.
4. Resource 2.3.3 *is intended to provide important background knowledge for Trainers, and not for instruction of the CHEWs. It may be useful during training, however, if questions arise around individual (relative) and population (attributable) risk.*

Resource 2.3.2: People who are most vulnerable to adverse health effects from HAP

Vulnerable groups are more likely to suffer the ill effects of exposure to household air pollution due to compromised immunity and increased susceptibility. The most important are:

- The pregnant woman and the unborn child.
- Children, especially babies, infants, and young children whose lungs, brains and other organs are still rapidly developing.
- The elderly and disabled.
- Those who are sick, e.g. with chronic illness such as ischaemic heart disease (IHD) and chronic obstructive pulmonary disease (COPD).
- Those with specific conditions with impaired immunity, e.g. HIV infection.

The WHO Air Quality Guidelines values (Unit 1.1) such as the annual guideline for $PM_{2.5}$ of 10 $\mu g/m^3$ and the 24-hour guideline for CO of 7 mg/ml, take into account scientific evidence on health risks among susceptible populations.

Resource 2.3.3: Individual and population risk

Note: This resource is provided to strengthen the knowledge and understanding of ***trainers*** *of the important concepts of relative and attributable risk. You may find this valuable in discussing (e.g. with colleagues, other ministries, the media, etc.), risk from HAP, especially in respect of groups most at risk and the burden of disease. You may also find this information useful in answering questions from the trainees. This resource is not intended primarily for instruction of the trainees, but can be used if these questions arise.*

In **Unit 2.3**, we have been looking at the risk of various diseases from HAP exposure, including for groups who are exposed the most, and vulnerable (susceptible) people.

Previously, in **Unit 2.1**, we studied the resulting 'burden of disease', that is, the deaths and illnesses that arise across the population due to HAP exposure, whether that be for the World, Africa, or Kenya.

One of the important ideas was that women and children tend to be at the highest risk of disease due to the higher levels and longer durations of exposure they experience. From this, we can say that, on average, the risk of any given disease such as COPD for a woman is higher than is the case for a man. We say: 'on average' because, of course, some men are exposed more than some women, but in general women do experience higher exposures. The risk of a disease (e.g. COPD) from exposure to a risk factor (e.g. HAP) is called the **'Relative Risk'**, because it tells us the risk ***relative*** to that for a person who is not exposed (or exposed less).

On the other hand, we noted when looking at the burden of disease data for Kenya that the numbers of deaths for men and women from the 'adult' diseases were very similar. We said this is because the underlying rates of disease such as COPD from the Kenyan population are higher for men, so a smaller increase in the *relative risk* for men (as compared with the *relative risk* for women) results in a similar number of deaths overall. This total burden from HAP exposure in the population is known as the **'Population Attributable Risk'** because it is the amount of disease that we can ***attribute*** to HAP exposure across the population.

It is important to understand these ideas around individual and population risk, because you may need to explain why:

- women and children are at higher individual risk of succumbing to ill-health from HAP exposure, but
- in the country as a whole, the number of deaths and levels of illness from HAP exposure is similar for men and women.

Please also refer back to the Burden of Disease material in **Unit 2.1**, as required.

Facilitation Step 2.3.3: Social and economic impacts of household energy use

1. Exercise 2.3.1: Ask the participants to work in groups to discuss the *four household energy supply and use scenarios* provided in the exercise. They should be encouraged to consider the social and economic impacts on the everyday lives and opportunities of families, especially of women and children.
2. Present and harmonize responses.
3. Lead a facilitated discussion on the implications for quality of life and of economic and other opportunities, drawing on the Commentary points in Exercise 2.3.1.

Exercise 2.3.1: Social and economic issues with household energy use

For this exercise, the participants can work in groups to discuss the economic and social issues relating to the following household energy supply and use scenarios:

1. Households cooking with wood fuel that is mainly collected from forest land.
2. Households cooking with charcoal and/or kerosene purchased from shops or kiosks.
3. Households cooking exclusively or mainly with LPG, with cylinder refills purchased from retail points such as filling stations or shops.
4. School or college students needing to study outside of daylight hours with the following options (try to discuss all of these):
   a. Kerosene lamps
   b. Solar photo-voltaic lamp (free-standing, not connected to grid)
   c. Mains (grid) electric lighting

Facilitators should encourage participants to draw on their own knowledge of how traditional household energy use affects the lives, wellbeing, social and economic opportunities for different members of the family. Facilitators can do the same.

Commentary:

Among the most important social and economic issues are:

- Time taken to collect and prepare (e.g. dry) wood and other solid fuel, and who is most involved in carrying this out; this most often is women, with some involvement of school-age children.
- Time taken to obtain fuels that are purchased, such as kerosene, wood, charcoal, gas, etc., and what is involved to carry or transport these fuels back to the home.
- The costs of fuels and energy (wood, charcoal, kerosene, LPG, electricity, etc.) that is purchased [Note that we will spend more time on fuel costs and affordability, including an exercise using a cost comparison tool, in **Unit 3**].
- Time that may be required to cook or carry out other tasks using stoves and fuels that are inefficient, or for school children and students to study where there is poor quality or intermittent lighting, e.g. kerosene lamps, candles, unreliable electricity supply.
- Impacts of these time 'budgets' on wellbeing, and opportunities for other activities, which might include engagement with learning and/or different economic and employment activities.
- The implications of fuel and energy supply issues, for example, intermittent availability of LPG gas refills, or unreliable mains electricity with black-outs or brown-outs.
- The importance of viewing these issues from a gender perspective in terms that include roles in the home, how the time of women is viewed and valued, how decisions that could change these conditions are made, etc.

A useful resource can be found through ENERGIA, which contributes to ensuring access to affordable, reliable and sustainable energy for all, including bringing sustainable energy solutions to people in hard to reach communities, advocating for gender-inclusive energy policies and practices, generating the evidence base to support gender-inclusiveness in the energy sector and sharing knowledge and best practices. More information can be found at the ENERGIA website: https://www.energia.org/

Another good source is: **Burning opportunities** - Clean household energy for health, sustainable development and well-being of women and children (WHO) pg. 15-18; 63-77.
https://www.who.int/airpollution/publications/burning-opportunities/en/

2.4 Testing and Standards for Cleaner and Safer Cooking

Purpose:

To equip participants with knowledge and understanding of:

- Recent developments in testing and standards for assessing and communicating the performance of cookstoves, addressing efficiency, emissions, safety and durability.
- How to interpret the results of standardized laboratory testing.

Training objectives	To understand and be familiar with: • The purpose of standardized laboratory testing of stoves and clean cooking solutions. • The approach taken to the testing of efficiency, emissions, safety, and durability within the ISO harmonized protocol. • Reporting of test results against the ISO voluntary performance target (VPT) tiers. • Interpretation of test results and how these may be applied in practice.
Duration	**90** mins
Methodology	Groupwork, facilitated discussion, exercise with ISO test reports.
Materials	LCD projector and laptop, video, flipcharts and marker pens, printed cards for ISO test results exercise.
Activity	Gaining familiarity with the purpose of ISO testing and reporting, and application of results for cookstoves.

Facilitation Step 2.4.1: Stove performance testing

1. Show the Video 'Performance testing for cookstoves', duration 3 minutes …
2. Present the key information about the testing of stoves, based on Resource 2.4.1.
3. Ensure understanding and answer questions.

Video ‘Performance testing for cookstoves’

This short video, which lasts 3 minutes, explains the rationale for testing solid fuel (e.g. wood, charcoal) cookstoves, and outlines the procedure using the new ISO harmonised test protocol. The testing is carried out in the certified laboratory at the Kenya Industrial and Research Institute (KIRDI) in Nairobi. Please note that the testing seen in the video is a demonstration for the purposes of filming only, and not a formal test of the stove illustrated. Furthermore, the test results in Exercise 2.4.1 are for training purposes only, and are not intended to reflect the performance of the stove in the video.

We discuss the interpretation of the test reports, and relevance to work with homes, later in the Unit in Exercise 2.4.1.

Resource 2.4.1: ISO testing of cookstoves and voluntary performance targets (VPTs)

Introduction:

The International Organisation for Standardisation (ISO) has recently developed a harmonized protocol for testing of ‘Clean cookstoves and clean cooking solutions.’ [ISO 2018]. The testing covers four aspects of performance, namely:

- Thermal efficiency (transfer of heat energy to the cooking pot).
- Emissions of $PM_{2.5}$ and carbon monoxide (CO).
- Safety.
- Durability.

International Workshop Agreement (IWA) Guidance:

These new ISO standards were developed in 2012 from an earlier initiative ‘Guidelines for Evaluating Cookstove Performance’, and some of you may be familiar with this. It was developed through a less formal ISO process known as an International Workshop Agreement (IWA). Information about this IWA on cookstove performance is available at: [https://www.iso.org/obp/ui/#iso:std:iso:iwa:11:ed-1:v1:en]. Although this standard has now been withdrawn (as it has been superseded by the new Standards described below), a considerable number of tests of efficiency, emissions, and safety using the guidance have been carried out and the results (rated in five tiers from Tier-0 (performance typical of an open fire) to Tier-4 (highest level of performance) are available for reference on stove performance. This information is a ‘Clean Cooking Catalog, hosted by the Clean Cooking Alliance: http://catalog.cleancookstoves.org/

Current ISO standards for clean cookstoves and clean cooking solutions:

Testing is carried out in a laboratory designated for this purpose, for example, the Kenya Industrial and Research Development Institute (KIRDI) in Nairobi. Although standardized testing in a laboratory tends to show the performance of any given stove at its very best, the results are at least consistent and comparable with other stoves and fuels tested using the same protocol. We know, however, that once a stove is in everyday use in a home, it will not perform as well as in the laboratory test.


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Testing a wood fuel cookstove in the laboratory at KIRDI, Nairobi.

If performance is relatively poor in the laboratory, we know that it will be even worse when in everyday use in the home.

ISO has also published **'Voluntary Performance Targets'** (VPT) [ISO 2018], setting out six tiers of performance for each of the test parameters listed above. These allow relatively simple assessment of performance which can be used when discussing the choice of stoves with households, communities, retailers, etc. We will look at an example of these VPT results in Exercise 2.4.1.

ISO testing and reporting of results:

The basis of the testing efficiency and emissions is a standard 'water boiling test', which is carried out at high, medium, and low power.

- **Thermal efficiency** is reported as a percentage (%) with and without 'char'. Char is the residual unburned fuel; if users tend to re-use this in the stove, the result 'with char' should be taken.
- **Emissions** of $PM_{2.5}$ and carbon monoxide (CO) are reported as emission rates for a given amount of energy delivered to the cooking pot, the units being mg/MJ delivered.
- **Safety** is based on a separate set of ten criteria listed in the table below, and presented as a score from 25 (very unsafe) to 100 (very safe, though not without any risk).

The ten criteria used in the ISO stove safety test

1. Sharp edges and points	2. Tipping
3. Containment of fuel	4. Obstructions near the cooking surface
5. Surface temperature	6. Heat transfer to the environment
7. Handle temperature*	8. Chimney shielding*
9. Flames surrounding the cooking vessel	10. Flames exiting the fuel chamber

**If fitted to the stove*

- **Durability** is also based on a separate set of tests (e.g. cracking, corrosion, etc.) and presented as a score from 0 (very durable) to a maximum of 37 (very poor durability).

Facilitation Step 2.4.2: Interpreting ISO stove test reports

1. Exercise 2.4.1: Provide the groups of participants with the tables showing the ISO stove test results and the VPT tier values (printed cards).
2. Explain that these first two tables give the results from testing of two stoves with quite different levels of performance. The results are in the standard reporting format recommended by ISO. The following steps should be followed for the exercise:

Step	Instructions to the groups
1	First, ask the participants to review the two test reports summarized in Tables 2.4.1(a) and (b) for Stoves A and B, respectively.
2	Ensure that the participants understand the results and how these are presented, referring back to Resource 2.4.1 if needed.
3	Now ask the participants to look at the VPT tier target levels shown in Table 2.4.2 and ensure that participants understand how these are presented.
4	For the Stove A test result [Table 2.4.1(a)], complete the last column with the relevant VPT tier level.
5	Repeat the reporting of the relevant VPT tier scores for the Stove B test report.
6	Emphasize to the participants that, when describing the performance of the stove, all four parameters (efficiency, emissions, safety, and durability) are to be reported.
7	Instruct the participants that for emissions, the lowest (poorest performance) tier value for $PM_{2.5}$ or CO is to be used.
8	Compare the two reports and comment on the performance of the two stoves.

3. Lead a facilitated discussion of the results for the two stoves, drawing on Table 2.4.3 summarizing the VPT Tier results and the Commentary points provided at the end of the exercise.

Exercise 2.4.1: ISO stove test reporting exercise:

Follow the steps set out in the Facilitation Step 2.4.2

Table 2.4.1(a): *Report on Stove A*

Metric		Test Sequence Phase				Performance against target (e.g., tier rating)
		High	Medium	Low	Combined*	
Thermal efficiency without char (%)	Mean	31.4	34.7	35.1	33.7	
	SD	1.9	1.7	2.1		
Thermal efficiency with char (%)	Mean	33.6	37.0	39.8	36.8	
	SD	2.2	1.6	2.0		
$PM_{2.5}$ per useful energy (mg/MJd)	Mean	497	203	216	305	
	SD	55	19	22		
CO per useful energy (g/MJd)	Mean	3.6	3.9	4.8	4.1	
	SD	0.5	0.7	0.9		
Safety	**Score**	**88**				
Durability	**Score**	**18**				

Table 2.4.1(b): *Report on Stove B*

Metric		Test Sequence Phase: High	Medium	Low	Combined*	Performance against target (e.g., tier rating)
Thermal efficiency without char (%)	Mean	38.1	40.2	41.6	40.0	**4**
	SD	2.1	2.2	2.4		
Thermal efficiency with char (%)	Mean	39.2	41.6	43.8	41.5	**4**
	SD	2.3	2.4	2.5		
$PM_{2.5}$ per useful energy (mg/MJd)	Mean	48	25	29	34.0	**4**
	SD	4.6	2.4	3.1		
CO per useful energy (g/MJd)	Mean	2.2	1.9	2.6	2.2	**5**
	SD	0.3	0.2	0.3		
Safety	**Score**	**69**				**2**
Durability	**Score**	**21**				**2**

Table 2.4.2: *Tier values for ISO Voluntary performance targets*

	Tier	Thermal efficiency (%)	Emissions (default)*: CO (g/MJd)	$PM_{2.5}$ (mg/MJd)	Safety (score)	Durability (score)
Better performance	5	≥50	≤3,0	≤5	≥95	<10
	4	≥40	≤4,4	≤62	≥86	<15
	3	≥30	≤7,2	≤218	≥77	<20
	2	≥20	≤11,5	≤481	≥68	<25
	1	≥10	≤18,3	≤1030	≥60	<35
	0	<10	>18,3	>1030	<60	>35

**Default values for emissions are based on typical conditions in homes (kitchen size, ventilation, and hours of use of stoves per day) across countries. Alternative values are available if the default values are considered inappropriate.*

Commentary:

Table 2.4.3: *Summary of VPT target scores*

<table>
<tr><th>Test parameter</th><th colspan="2">VPT Tier – Stove A</th><th colspan="2">Tier – Stove B</th></tr>
<tr><td>Thermal efficiency without char (%)</td><td colspan="2">3</td><td colspan="2">4</td></tr>
<tr><td>Thermal efficiency with char (%)</td><td colspan="2">3</td><td colspan="2">4</td></tr>
<tr><td>$PM_{2.5}$ per useful energy (mg/MJd)</td><td>2</td><td rowspan="2">2</td><td>4</td><td rowspan="2">4</td></tr>
<tr><td>CO per useful energy (g/MJd)</td><td>4</td><td>5</td></tr>
<tr><td>Safety</td><td colspan="2">4</td><td colspan="2">2</td></tr>
<tr><td>Durability</td><td colspan="2">3</td><td colspan="2">2</td></tr>
</table>

1. Stove A: from an emissions (health) perspective, this stove was scored overall at Tier-2, which is towards the lower end of performance. On efficiency it was average, safety was good, and durability average
2. Stove B: although from an emissions perspective, the stove scored quite well at Tier-4, and efficiency was also good, there were clearly concerns about safety and durability, both of which scored Tier-2.

Facilitation Step 2.4.3: Applying the test results

1. Explain to participants that the final step will be to look at how we can apply these test results in practice.
2. Present the table from Resource 2.4.2 which provides an explanation of the VPT tiers in everyday language.
3. You can refer back to the Stove A and B test results summarized in Table 2.4.3 to discuss the performance of each.
4. Lead a facilitated discussion on how this information might be used in discussion with a household about the choice of a new cookstove, using language and other means to communicate the four components of stove performance to members of a household.

Resource 2.4.2:

What do these Tier-scores mean in practice, and how should they be communicated?

Tier-0 represents performance that can be expected from an open fire or simple, traditional solid fuel stove. Tier-5 is the very best performance that can be expected from household devices and fuels. More detail is given in the table below for each tier across the four parameters, while the precise definitions are available in the ISO VPT documentation.

Table: *Explanation of the VPT tiers in everyday language*

<table>
<tr><th>Tier</th><th>Efficiency</th><th>$PM_{2.5}$*</th><th>CO*</th><th>Safety</th><th>Durability</th></tr>
<tr><td>5</td><td>Very good: similar to a gas cooker</td><td>Meets WHO Guideline (10 μg/m³): minimal health risk</td><td>Meets WHO Guideline (7 mg/m³): minimal health risk</td><td>Very good, but not without any risk</td><td>Very good, should last well</td></tr>
<tr><td>4</td><td rowspan="4">Equal divisions of the score across tiers</td><td rowspan="2">Small to moderate health benefit</td><td rowspan="2">Moderate long-term health benefit and low risk of toxicity</td><td rowspan="4">Equal divisions of the score across tiers</td><td rowspan="4">Equal divisions of the score across tiers</td></tr>
<tr><td>3</td></tr>
<tr><td>2</td><td rowspan="2">Very little health benefit</td><td rowspan="2">Some long-term health benefit and small risk of toxicity</td></tr>
<tr><td>1</td></tr>
<tr><td>0</td><td>Very poor: similar to an open fire</td><td>No health benefit</td><td>No long-term health benefit and moderate risk of toxicity</td><td>Very poor, with serious safety concerns</td><td>Very poor, can expect to deteriorate rapidly</td></tr>
</table>

**The tier values for $PM_{2.5}$ and CO are based on assessments of actual risks to health; for full explanations, see ISO VPT documentation; note that for CO, the health effects include both adverse effects of long-term exposure at low levels and toxic effects of short-term exposure to high levels [ISO 2018b]*

Further reading and reference sources

1. 'Guidelines for Evaluating Cookstove Performance' (IWA) ISO/IWA 11:2012 (en): https://www.iso.org/obp/ui/#iso:std:iso:iwa:11:ed-1:v1:en
2. Clean Cooking Catalog: http://catalog.cleancookstoves.org/
3. ISO 19867-1:2018 Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 1: Standard test sequence for emissions and performance, safety and durability. Available (to purchase) at: https://www.iso.org/standard/66519.html
4. ISO/TR 19867-3:2018 Clean cookstoves and clean cooking solutions -- Harmonized laboratory test protocols -- Part 3: Voluntary performance targets for cookstoves based on laboratory testing. Available (to purchase) at: https://www.iso.org/standard/73935.html?browse=tc

2.5 Field visit: Consolidating Knowledge and Exploring Household Perspectives

Purpose:

To provide participants with the opportunity to:

- Consolidate knowledge gained up to this point in the training.
- Discuss household energy use, risks to health and safety and perspectives on change with people in their homes.

Training objectives	To observe energy use in homes and discuss the topic with households in order to: • Consolidate knowledge gained on household energy use, health and safety risks and approaches to prevention of adverse impacts. • Explore perspectives of household members on risks to health and safety of energy use in the home, and their views of changing to cleaner, safer, and more efficient fuels and technologies. • Explore opportunities for reducing exposure through ventilation and other means. • Identify some of the opportunities and challenges that are likely to arise as they, and community health volunteers, work with households and communities to encourage and support change.
Duration	**180** mins
Methodology	Group visits to homes, observation, questions and notetaking, group reflection and presentation, facilitated discussion, exercise with ISO test reports.
Materials	Two or more homes identified in advance and having given their permission; ideally select one using exclusively solid fuels, one using some modern fuel, e.g. LPG along with some solid fuel or kerosene (stacking); LCD projector and laptop, flipcharts and marker pens.
Activity	Home visits to explore energy use and issues involved in changing to cleaner energy and starting to identify issues community health workers will need to address in their work.

Facilitation Step 2.5.1

1. Explain to the participants the purpose, plans for the home visits including discussing the key points listed in Exercise 2.5.1.
2. Depending on the size of the overall group and number of homes that have been identified and given permission (this should be at least two), organise the groups for the visits.
3. At least one trainer should accompany, observe, and encourage each group to complete the exercise, as required.
4. Following the home visits, participants are asked to return to the training centre, spend some time consolidating what they have learned, write this up and then present their main findings.
5. Lead a facilitated discussion and wrap up with pointers to the aims of Unit 3 (to look at interventions for cooking, lighting, reducing exposure, etc.), answering any questions the participants may have.

Exercise 2.5.1: Home visits to explore energy use and perspective on change

Trainers should encourage participants to talk to households about what they feel is important and relevant, although it is recommended that the following topics are covered.

- Fuel, energy, and technologies used for cooking, lighting, heating water, space heating/warmth, and any other uses in and around the home.
- A chart may be useful for notetaking (see example below); this can also serve to record planned or possible changes the household is considering, or may consider:

Application in the home	Current		Planned [ ] or Aspire to [ ]	
	Fuel/energy	Technology	Fuel/energy	Technology
Cooking (1)				
Cooking (2)				
Lighting (1)				
Lighting (2)				
Water heating				
Space heating/warmth				
Other:				
Other:				

- Views on symptoms and health concerns from smoke, and experience of actual ill-health in the family thought to be caused by smoke.
- Views on safety concerns, and experience of actual injuries in the family such as burns and scalds.
- Potential barriers to planned or aspirational changes (as per chart), including:
  - Knowledge of options
  - Suitability for cooking food, taste, etc.
  - Cost of initial purchase
  - Cost of fuel
  - Availability and interruptions in supply
  - Fears about safety
  - Other [specify]
- Opportunities for, and barriers to, improving ventilation.
- Opportunities for, and barriers to, reducing exposure by avoiding smoke and through other means.
- Trainers can encourage participants to start thinking about what Job-Aids they would find most helpful for these interactions with households, noting that some aids (e.g. cost-comparison tool) will be covered in Unit 3.

Provisional time plan for field visit

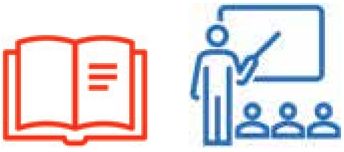
Component	Location	Duration (mins)
Facilitator explanation of exercise	Training centre	20
Walk to home	Community	15
Home visit*	Community	50
Walk to training centre	Community	15
Break/catch-up		10
Groups consolidate and write notes	Training centre	20
Groups present their main ideas with facilitated discussion	Training centre	30
Wrap up and final Q&A	Training centre	20
Total time		**180**

*If logistics allow, it may be possible for each group to visit both homes, swapping over half-way through the time allocated to home visits.

UNIT 3

Household Air Pollution: Primary Prevention Strategies

3.1 Primary Prevention Through Improved Cooking Solutions



Purpose:

To equip participants with knowledge and understanding of:

- The role of cleaner cooking in primary prevention of HAP through reduced emissions from improved cooking technologies and cleaner fuels.
- The potential barriers to adopting these options and practical solutions.

Training objectives

By the end of this Unit, the participants should be able to:

1. Identify the role of traditional cooking technologies used in the community in creating HAP.
2. List various types, usage, and benefits and limitations of cleaner cooking technologies.
3. Describe cooking with clean fuels (such as LPG, electricity, etc.) in terms of practicality, safety, and benefits in relation to cutting out HAP emissions.
4. Identify barriers limiting the uptake of cleaner cooking technologies and fuels
5. Understand the issue of fuel stacking (multiple fuel use) and how this may impact on HAP emissions.
6. Recommend solutions to promote the uptake of cleaner cooking technologies/ fuels and to reduce emissions.

Duration

90 mins

Methodology	Groupwork, photos (chart), mini lecture, facilitated discussion and role-play, demonstration (including use of improved stove, LPG cooker, etc., if feasible and time permits).
Materials	LCD projector and laptop, chart of photos of the cookstove and fuel types, flipcharts and marker pens
Activity	Builds on the field visit (Unit 2.5) to examine the benefits and limitations of clean cooking technologies, the barriers to uptake and how these can be overcome. The demonstration indicated in the methodology could be very useful to help engagement with the technology, performance and practicalities, but may create logistic challenges if built into the training. However, depending on logistics it can be an option for trainers to consider.

Facilitation Step 3.1.1: Characteristics of the various fuel and technology options for cleaner cooking

1. Exercise 3.1.1: Ask the participants to work in groups and make the printed charts of photos available to each group. Ask them to work through each cookstove/fuel type (photo), discussing and recording their views; we suggest using a scoring system in the space provided. Encourage the participants to make notes as well.
2. Remind the groups of what we are looking for with respect to cleaner cooking interventions:

   As covered in **Unit 1.2**, when considering options for cleaner cooking, we want to ensure that these:
   - Can provide substantial benefits to health
   - Can be used in the home with a high level of safety
   - Meet the needs of the household
   - Are available (including ongoing fuel requirements) and affordable
   - In terms of emissions, fuel type, and supply, etc., are consistent with the country's goals for sustainable development and protection of the climate.
3. Ask each group to present their chart and talk through their scores and notes.
4. Lead a facilitated discussion of the group responses, including in areas of agreement and difference.
5. Inform the participants about the Clean Cooking Alliance Catalog which is an important resource of cookstove testing performance.

Exercise 3.1.1: Characteristics of cleaner cooking options

Use the chart with photos (which can also be printed separately) to discuss and record your perspectives on the **health benefits** (emissions), **safety**, and **availability** (technology and fuel) of the fuel and stove types illustrated.

These include the open fire or traditional wood stove as a **baseline** with which to compare the other types illustrated, most of which are considered 'improved' in some respect.

Participants are encouraged to discuss availability in the county or area in which they live and work, but general availability across the country can also be discussed. For now, focus on how easy or difficult it would be for potential users of a stove and fuel to obtain these if they wanted to and could afford them. The **costs** are of course a very important aspect of whether or not a specific option is 'available' to a given household, but we will return to this later, and in more detail in Unit 3.6.

Participants can record their views in the columns headed: Emissions, Safety, and Availability, using a score as follows:

- 1 = very poor
- 2 = poor
- 3 = good
- 4 = very good

Photo chart for discussion and assessment of cookstove and fuel types:

Fuel and technology		Participants' views and experience (score)		
		Emissions (how clean?)	Safety	Availability
	**Open fire and traditional mud stove:** these come in various forms, some using three stones to support the pot, others (as illustrated here) a mud surround.			
	**Improved mud stove:** there is a wide variety of designs. This is a Kenyan Upesi stove with a ceramic insert for better combustion.			
	**Improved wood stove:** this uses the so-called 'Rocket' technology for the combustion chamber. This model is an Envirofit design in use in a Kenyan home.			

Fuel and technology		Participants' views and experience (score)		
		Emissions (how clean?)	Safety	Availability
	**Advanced e.g. fan stove:** this example is a 'Philips' stove. It burns small pieces of wood. A fan and special combustion chamber help to achieve more complete fuel combustion.			
	**Improved charcoal jiko:** this may be metal or ceramic, and is designed to improve the combustion of the charcoal fuel compared to a traditional model. *Ministry of Health, Uganda*			
	**Stove with flue:** a flue is a pipe attached to the stove. This example is an Indian-made Prakti in use in a Kenyan home.			
	**Ethanol stove:** a 'Clean-cook' model, burning alcohol stored in an absorbent tank in the cooker. The fuel is distilled from crops and residues including sugar.			

Fuel and technology		Participants' views and experience (score)		
		Emissions (how clean?)	Safety	Availability
	**LPG stove:** this may be a single burner fixed to the gas bottle or a double (or more) burner operating at lower pressure and connected via a regulator valve and rubber hose.			
	**Biogas stove:** this requires a supply (pipe) of gas produced in a digester fed with animal dung and human waste, and water. The digested 'slurry' is a good fertiliser			
	**Electric cookers:** cookers may have one or two rings, occasionally more. Mains supply is usually needed. Induction stoves are very efficient. Electric pressure cookers may also be useful.			
	**Solar Solar cooker:** these come in various designs, but essentially focus solar heat on the cooking pot. Although the energy is free, cooking is restricted to times of day when there is adequate solar radiation; in practice, it has been found that households can carry out 30-40% of their cooking, on average using a solar cooker. *Photo*: https://www.solarcooker-at-cantinawest.com/solarcooking-howitworks.html			

Catalog of stove performance data:

The **Clean Cooking Alliance** [http://catalog.cleancookstoves.org/] holds a **Catalog** of several hundred stove types from around the world, with test results where these are available. These tests are based on the ISO 'International Workshop Agreement' which was the forerunner of the new ISO testing protocol and voluntary performance targets.

Facilitation Step 3.1.2: Key features of cleaner cooking options

1. Building on the exercise just completed (3.1.1), present the key features of options for cleaner cooking, based on Resource 3.1.1. Cover all of the headings:
   a. Emissions
   b. Safety
   c. Costs and availability
   d. Fixed and portable stoves
   e. Chimneys and flues
   f. What should, and should not, be recommended
   g. Stacking (see point 3 below)
2. Encourage participants to share their personal experiences in respect of the advantages and disadvantages of the various stoves and fuels.
3. Stacking with mixed fuel types can be expected to result in higher levels of HAP than would be the case if the clean fuel was used exclusively.
4. Ensure there is good understanding and answer questions.

Resource 3.1.1: Key features of cleaner cooking options

Emissions:

- Clean liquid and gaseous fuels (LPG, biogas, ethanol) have very low emissions and when used in the home meet WHO air quality guideline values for both $PM_{2.5}$ and CO in everyday use. In general, all combustion stoves should be used in a ventilated area.
- Electrical stoves produce no emissions of $PM_{2.5}$ or CO at the point of use, but it is important to consider how the electricity has been generated and the impacts on the population that may be exposed to pollution from power plants.
- Kerosene use as a household fuel is discouraged by WHO. Emissions of $PM_{2.5}$ from non-pressurized stoves (most common) are higher than from pressurized stoves and are at levels which pose a risk to health.

- Improved solid fuel (e.g. wood) stoves vary a lot in terms of design and performance, with advanced designs (which use fans to obtain more complete combustion) delivering $PM_{2.5}$ levels of not far above WHO guideline levels in ideal (laboratory) conditions with dry fuel. Studies show that in practice, when in everyday use in homes, performance is not as good. Simpler designs, such as rocket stoves, do reduce $PM_{2.5}$ levels compared to open fires and traditional wood stoves, but only to levels well above the WHO guideline, and performance is also worse in everyday use compared to the laboratory setting.

Safety:

The main safety issues with cookstoves have been discussed in Unit 2.2, and this can be referred back to as required. Perceptions of safety may differ markedly from actual safety in practice.

Costs and availability:

There are two main components to the costs of technology fuels used for cooking:

- The stove and associated equipment, for example in the case of LPG the bottle, regulator, and hose, and with electrical cooking the connection to the mains power, wiring, meter, and switching. Biogas units have high initial construction and installation costs.
- The ongoing costs of using the fuel/energy source, which may be free where solid biomass is collected, or all or part of the household's needs may be purchased. Processed biomass such as charcoal has to be purchased, as do the other fuels and electricity. Obtaining the fuel may incur costs such as transport for large amounts and/or heavy items such as 12.5 kg LPG bottles. Maintenance costs for stoves and the associated equipment also need to be considered.

In general, it can be said that in order to achieve low emissions and avert the adverse health and other consequences of household energy use, relatively expensive liquid or gaseous fuels, or electricity, are required. Although these, and the stoves required to cook with them, are seen as expensive, this situation is changing and should be assessed, not assumed. The cost-calculator tool [initial draft] described in Unit 3.6 can help with assessing and comparing the costs of current and cleaner alternatives.

Costs of fuel vary, and it will be useful for facilitators (and CHEWs) to have to hand up to date prices of the main fuels across the country. Availability is linked to cost, demand, and wider economic and market factors.

For example, although wood may be 'freely' available in nearby forests, charcoal production, land ownership changes, and environmental protection policy may all affect how available such fuelwood is, and the time required to collect it.

LPG availability is growing in Kenya, but it is still mainly centred in and close to urban areas, but can also be obtained at many filling stations in other parts of the country.

Electrical power of sufficient capacity to enable cooking requires a mains connection, so the infrastructure for that must be available and installed. This may be very expensive. Loss of electrical power, which may be partial (voltage drop) or total, during times when the household wishes to cook, will push users back onto alternative fuels (stacking).

Fixed and portable stoves:

- Portable stoves can be carried and used in different locations, easy to carry, and can be used both in urban, rural, and rented units. For solid fuels these mostly use charcoal, but LPG and electric cookers are also usually portable.
- Fixed stoves are permanently fixed on the floor and are ideal for rural households and mostly use firewood.

Both have their uses, advantages, and disadvantages. Portable combustion stoves, e.g. charcoal or kerosene, can present safety risks as these may cause burns if carried while alight, or spillage of fuel and fires.

Chimneys and flues:

Some means of venting emissions to the outside of the kitchen or home with a chimney or flue can reduce levels of pollution inside; the various designs and their effectiveness are discussed further in Unit 3.4. A chimney is built-in, a flue is a pipe attached to the stove and venting outside. The ISO testing protocol reports emissions directly into the room (as well as total emissions), so this gives an indication of how effective the flue is, if fitted.

What stoves should, and should not, be recommended?

Clean stoves using liquid or gaseous fuels, or electricity, can be recommended if they are suitable, available and affordable, and safety issues are addressed – for example with LPG, the bottles are always exchanged and checked when refills are needed, and that users are instructed in safe practices.

WHO discourages the use of kerosene as a household fuel.

The Clean Cooking Alliance hosts and maintains a 'Clean Cooking Catalog', which is available at:
http://catalog.cleancookstoves.org/. This catalog holds tests results for a very wide range of stoves, based on the earlier International Workshop Agreement (IWA) test and reporting protocol which covered efficiency, emissions of $PM_{2.5}$ and CO and safety with five tiers: 0 for open fires/traditional stoves, and 1-4 for improved stoves with Tier-4 being the best.

Please refer to **Unit 2.4** for interpretation of the tiers of performance for efficiency, emissions, safety and durability. The Ministry of Health will provide updated guidance on what levels of performance are considered acceptable, and hence what stoves can be promoted.

Stacking:

This is when more than one type of fuel and technology is used and may occur if household needs are not met by the cleaner stove, the household cannot afford to carry out all of their cooking with the cleaner fuel, or the fuel is not always available. Stacking will tend to result in higher levels of HAP than would be the case if the clean fuel was used exclusively.

Stacking is almost inevitable as households start to transition to cleaner and more efficient stoves and fuels. While it is not the ideal situation in terms of reducing HAP as much as possible, it does signify that new technologies and fuels are being used to some extent. The goal should be to encourage households to use the cleanest options as much as possible, and ultimately – when cost, availability, cultural or other barriers that hold them back have been overcome - exclusively.

Facilitation Step 3.1.3: Role play exercise on barriers and how to overcome these

1. Ask the participants to carry out Exercise 3.1.2 (role play) in groups, dividing each group into one or more in the roles of:
   a. Community Health Worker visiting a home
   b. Members of a household
   c. Observers and note-takers
2. Once the groups are established, they should role-play a scenario of their choice in which they talk to the household about their cooking, lighting, etc., the health and safety risks, and how changing to cleaner and more efficient options would be beneficial. The group should anticipate barriers, try to find ways of overcoming these. The observer/note-taker should record the main points.
3. Groups present their scenarios and the outcome of their role-play on barriers and solutions.
4. Lead a facilitated discussion based on the Table in Exercise 3.1.2, ensuring that all of the sections (topics) are covered, and that additional barriers raised by the participants are recorded and discussed.

Role Play Exercise 3.1.2: Barriers to change and how to overcome these

Here we list the main barriers (Participants may identify others) and how these can be addressed, which we term **solutions**.

These solutions may include some action that can be developed in the local community through community dialogue, action days leading to action plans.

The solutions also include action needed by the government and other stakeholders, including the marketers and suppliers of clean fuels and energy. Reporting (Unit 4) provides an opportunity to highlight and communicate issues that need addressing at this higher level in the country.

Topic	Specific barriers	How to address ('solutions')	Priority
Socio-cultural	Lower education level of women is associated with greater reluctance to change; the time of less-educated women may also be less valued.	Spend time with households, both men and women, and older people, to explain and raise awareness of adverse impacts of household energy and HAP, and how to address them. Children can play an important role as agents for change – it is their future, and many school-age children will become parents within a few years. General awareness-raising, including through working with the media.	
	Large household size requires more energy but may mean there is more labour available to collect firewood (less incentive to change).		
	Older age is associated with a greater reluctance to change.		
	Cultural beliefs, such as how best to cook certain foods to ensure familiar taste may prevent change to a clean fuel such as LPG.	Cooking demonstrations can help show that most, if not all, foods can be cooked on clean fuels to people's satisfaction.	
	Community interactions, e.g. where poor experiences with a particular stove are passed on may contribute to community-wide resistance to change. The opposite may apply to good experiences.	Community dialogue and action days can help understand what perceptions are current and change these based on evidence.	
	Other from participants:		
Economic	Income level may be insufficient to purchase stoves and cover ongoing fuel costs.	Support households in reviewing costs (see Unit 3.6). Loans may be available to help with initial costs. Saving can smooth fluctuations in income. Report experience from work with homes to encourage more supportive government policy on pricing and tax, and financial institutions to provide consumer-friendly packages and products.	
	Irregular or seasonal income variations may further undermine the ability to cover ongoing fuel costs		
	Other priorities for household expenditures such as school fees, healthcare, etc., may compete, and be seen as more important.	Assess actual costs, and emphasize the importance of cleaner, safer energy, which can contribute to lowering other expenses, e.g. health care.	
	If habitually purchase fuel in small quantities (e.g. charcoal, kerosene), the large outlay e.g. a 12.5 kg LPG cylinder refill is perceived as unaffordable.	Assess actual costs, and whether saving is feasible and helpful. Innovations such as PAYGO energy allow the use of LPG on a 'pay-as-you-go' basis.	
	Other from participants:		

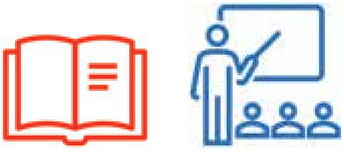
Topic	Specific barriers	How to address ('solutions')	Priority
Stove and fuel: factors other than actual affordability	Perceived cost	Assess actual costs and discuss with households and communities (Unit 3.6).	
	Perceived as unsafe [this applies in particular to LPG and national level action to ensure a safe and well-regulated market is critical]	If a stove has been found to be unsafe on testing, it should not be promoted. Educate households and communities about actual levels of safety and key aspects of safe usage.	
	Not suitable for household needs	Work with households to determine which fuel/stove options meet needs best.	
	Unavailable, or only available intermittently	Assess availability, report to encourage government, marketers, and suppliers to improve availability of fuels, electrical supply, and connections, etc.	
	Non-durable	If a stove has been found non-durable on testing, it should not be promoted	
	Low emissions and fuel-saving not as expected among users now seeking these features	If a stove has been found to be IWA Tier-2* or worse on emissions testing, it should not be promoted.	
	Other from participants:		

Tier-3 in the new ISO testing and voluntary performance targets [see **Unit 2.4]*

Reading and Resource Materials

1. Clean Cooking Catalog: http://catalog.cleancookstoves.org/
2. Opportunities for transition to clean household energy in Kenya: Application of the WHO Household Energy Assessment Rapid Tool (HEART) pg. 24
3. Kenya Climate Innovation Center: - Sector Mapping and Market Assessment on Improved Cookstoves (ICS) Sector in Kenya

3.2 Primary Prevention Through Improved Lighting Solutions



Purpose:

To equip participants with knowledge and understanding of:

- The role of cleaner lighting in primary prevention of HAP through reduced emissions from improved lighting technologies and cleaner fuels/energy sources.
- The potential barriers to adopting these options, and practical solutions.

Training objectives	By the end of this Unit, the participants should be able to: 1. Identify lighting technologies currently used within the community and contributions to HAP and safety hazards. 2. List benefits of clean lighting technologies (solar lights, electricity, torches, etc.) from reductions in HAP, improved safety (e.g. reduction in risk of fire and burns), and social (more lighting for education, commercial activities, etc.). 3. Identify potential barriers to the adoption and use of clean lighting technologies. 4. Recommend solutions aimed at promoting the uptake of clean lighting technologies.
Duration	 **60** mins
Methodology	Groupwork, photos (chart), mini lecture, facilitated discussion, demonstration (including use of improved lighting, e.g. solar lamps, etc., feasible and time permits.).
Materials	LCD projector and laptop, chart of photos of the cookstove and fuel types, flipcharts and marker pens.
Activity	Builds on the field visit (Unit 2.5) to examine the benefits and limitations of clean lighting technologies, the barriers to uptake, and how these can be overcome.

Facilitation Step 3.2.1: Traditional lighting fuels and technologies

1. Present each of the photos from Resource 3.2.1 that illustrate traditional lighting fuels and technologies.
2. Lead discussion for each one on the potential problems in respect of:
   a. Emissions, HAP and health
   b. Safety
   c. Social and economic activities
3. Present and discuss the definition of clean and effective lighting provided at the end of Resource 3.2.1.

Resource 3.2.1: Traditional, polluting, and unsafe forms of lighting

Here, we illustrate five sources of lighting that are polluting and often unsafe. The pressurized kerosene lamp is very much cleaner than the simple tin lamp. It is also cleaner than the non-pressurized lamp with a glass cover. All kerosene devices require that the fuel is stored safely to prevent spillage and poisoning of children. In general, WHO discourages the use of kerosene as a household fuel.

Firewood

Candles

Kerosene wick lamp with cover

Tin kerosene lamp with wick

Illustrations: Ministry of Health, Uganda

Figure 5 Pressure lamp

Definition: clean and effective lighting

- Clean lighting refers to the use of lighting energy sources that have less (or no) emissions of HAP and consequently reduced the risk of ill-health.
- The lighting should provide sufficient illumination for carrying out activities such as cooking, reading, studying, or sewing, safely and effectively.
- The lighting should be reliable in terms of the supply of fuel or energy.
- Safety should not be assumed, but assessed.

Facilitation Step 3.2.2: Characteristics of the fuel and technology options for clean lighting

1. Exercise 3.2.1: Ask the participants to work in groups and make the printed charts of cleaner lighting photos available to each group. Ask them to work through each lighting type (photo), discussing and recording their views; we suggest using a scoring system in the space provided. Encourage the participants to make notes as well.
2. Remind participants of the definition of clean and effective lighting, which sets out what we are looking for.
3. Ask each group to present their chart and talk through their scores and notes.
4. Lead a facilitated discussion of the group responses, including of areas of agreement and difference.
5. Use the resource on 'Benefits of clean and efficient lighting' at the end of Exercise 3.2.1 to consolidate this learning.

Exercise 3.2.1: Clean lighting options

Use the chart with photos (which can also be printed separately) to discuss and record their own perspectives on the **health benefits** (emissions), **safety**, and **availability** (technology and fuel) of the lighting and fuel/energy types illustrated.

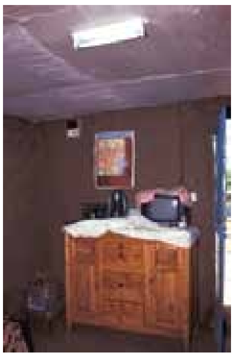
It may be most useful for participants to consider availability in the county or area in which they live and work, but general availability across the country can also be discussed. For now, focus on availability in terms of whether potential users can obtain the lighting and fuel if they wanted to and could afford them. The **costs** are of course a very important aspect of whether or not a specific option is 'available' to a given household, but we will return to this later, and in more detail in Unit 3.6.

Participants can record their views in the columns headed: Emissions, Safety, and Availability, using the scoring system below:

- 1 = very poor
- 2 = poor
- 3 = good
- 4 = very good

Chart for discussion and assessment of lighting options:

Fuel and technology	Participants' views and experience (score)		
	Emissions (how clean?)	Safety	Availability
 **Electric light bulb:** this example is a light-emitting diode (LED) bulb, which is expensive but very efficient. Older incandescent bulbs, where available, are much cheaper but inefficient so more expensive to run. This type of LED bulb usually requires mains electricity (or local grid).			
 **Fluorescent strip lamp:** these are quite expensive to purchase, but cheap to run. Most require mains electricity or a local grid.			
 **Compact fluorescent bulb:** these are quite expensive to purchase, but cheap to run. Most require mains electricity, or a local grid.			

Fuel and technology		Participants' views and experience (score)		
		Emissions (how clean?)	Safety	Availability
	**Solar photo-voltaic lamp:** the lamps use LEDs powered by a battery that is charged during the day by a solar cell. After the initial purchase, there are no running costs.			
	**LPG Lantern:** This uses LPG in a small bottle held in the base, and a mantle for illumination. Apart from the initial cost, the lamp requires gas refills.			
	**Electric torch:** This uses batteries, which need to be replaced at intervals. If re-chargeable batteries are used, a charger and sources of electricity are needed.			
 	**Solar panel system:** this is similar to the solar PV lamp, but on a larger scale. This example uses a fluorescent strip lamp. Following the initial purchase and installation, there are no running costs unless maintenance is required.			

Benefits of clean and efficient lighting:

There are substantial health and environmental benefits to be realized by transitioning households to electric lighting and other recommended improved lighting technologies. Improved lighting technologies are innovations that offer considerable improvements in energy efficiency, environmental health, and safety, when compared with conventional lighting technologies. At the same time, they usually provide a better quality of light and overall can save money.

Solar and electric lamps are the most household-friendly options, and they are the lighting methods of choice to be recommended. They do not produce emissions of combustion pollutants, are very safe (so long as electrical wiring with mains-powered lights is correctly installed and maintained), and can be used for longer than traditional lighting sources. The initial costs may be relatively high, but ongoing costs are zero (solar) or very low in the case of LED bulbs. The durability (lifetime) of these products must also be taken into account, as replacement can be expensive.

Facilitation Step 3.2.3: Barriers to changing to clean lighting

1. Lead a facilitated discussion using the barriers headings from Resource 3.2.2, covering:
   a. Socio-cultural
   b. Economic
   c. Lighting and energy: factors other than actual affordability
2. Compare and contrast the barriers and solutions with those discussed in Unit 3.1 for cleaner cooking, identifying those that are common and those which are specific to lighting (e.g. where mains electricity is used, the reliability of supply, etc.)

Resource 3.2.2: Barriers to changing to clean lighting:

Here we list the main barriers (Participants may identify others) and how these can be addressed, which we term **solutions**.

As with cooking, these solutions may include some action that can be developed locally through community dialogue, action days leading to action plans.

The solutions also include action needed by the government and other stakeholders, including the marketers and suppliers of clean fuels and energy. Reporting (Unit 4) provides an opportunity to highlight and communicate issues that need addressing at this higher level in the country.

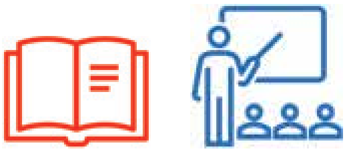
Topic	Specific barriers	How to address ('solutions')	Priority
Socio-cultural	Lower education level of women is associated with greater reluctance to change;	Spend time with households, both men and women, and older people, to explain and raise awareness of adverse impacts of household energy and HAP, and how to address them. Children can play an important role as agents for change – it is their future, and many school-age children will become parents within a few years. General awareness-raising, including through working with the media.	
	Older age is also associated with a greater reluctance to change.		
	Community interactions, e.g. where poor experiences with a particular lighting type are passed on may contribute to community-wide resistance to change. The opposite may apply to good experiences.	Demonstrations can help show the benefits and practical aspects of new lighting technologies. Community dialogue and action days can help understand what perceptions are current and change these based on evidence.	
	Other from participants:		
Economic	Income level may be insufficient to purchase lamps. Energy costs are relatively low, however (zero for solar, and low for LED bulbs), although batteries for torches are a significant cost, but in general these ongoing expenses are less of a barrier than for cooking.	Support households in reviewing costs (see Unit 3.6). Loans may be available to help with initial costs. Report to encourage more supportive government policy on pricing and tax, and financial institutions to provide consumer-friendly packages and products.	
	Other priorities for household expenditures such as school fees, healthcare, etc., may compete, and be seen as more important.	Assess actual costs, and emphasize the importance of cleaner, safer lighting energy which can contribute to lowering other expenses, e.g. health care.	
	Other from participants:		

Topic	Specific barriers	How to address ('solutions')	Priority
Lighting and energy: factors other than actual affordability	Perceived cost	Assess actual costs and discuss with households and communities (unit 3.6).	
	Perceived as unsafe [this applies in particular to LPG and national level action to ensure a safe and well-regulated market is critical]	If a lighting/fuel combination is known to be a safety risk, it should not be promoted. Educate households and communities about actual levels of safety and key aspects of safe usage.	
	Not suitable for household needs	Work with households to determine which lighting options meet needs best.	
	Unavailable, or only available intermittently	Assess availability, report to encourage government, marketers, and suppliers to improve the availability of lights, electrical supply, and connections, etc.	
	Non-durable or otherwise of poor quality	If a light is known to be non-durable and of poor quality, it should not be promoted	
	Other from participants:		

Further reading

1. Accelerating the Global Adoption of ENERGY-EFFICIENT LIGHTING, UN Environment Global Environment Facility | United for Efficiency (U4E) pg. 4
2. Opportunities for transition to clean household energy in Kenya Application of the WHO Household Energy Assessment Rapid Tool (HEART) pg. 14
3. Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children. pg. 66

3.3 Improved Space and Water Heating Solutions



Purpose:

To equip participants with knowledge and understanding of:

- The space and water heating needs of homes.
- The technologies and fuels that can best address these if the fuels and stoves used for cooking are not sufficient.
- Barriers to their adoption and how these can be addressed.

Training objectives	By the end of this Unit, the participants should be able to: 1. Identify space and water heating, and other household energy needs, in homes. 2. Determine which of these needs can be met by proposed cooking technologies, fuels and other solutions, and which will require alternative technologies fuels. 3. Identify what alternative technologies and fuels will meet these needs while ensuring low emissions, safety, efficiency, affordability, and availability. 4. Identify barriers limiting the adoption and use of these technologies, fuels and other solutions and make recommendations for solutions.
Duration	 **60** mins
Methodology	Groupwork, photos (chart), mini lecture, facilitated discussion.
Materials	LCD projector and laptop, flipcharts and marker pens.
Activity	Builds on the field visit (Unit 2.5) to examine the needs for and solution to water and space heating requirements, the barriers to uptake, and how these can be overcome.

Facilitation Step 3.3.1:

1. Ask the participants (individually or in groups) to discuss space, water, and any other heating needs in homes and how fuels and technologies are generally used to meet these requirements.
2. Cooling (i.e. air conditioning) is becoming increasingly important with climate change: trainers and participants in some settings may wish to include this in the discussion.
3. Record the group's responses on a flipchart.
4. Present the definitions in Resource 3.3.1. Ensure understanding and that all heating needs (which will of course vary by geography, altitude, and climatic conditions) have been covered.

Resource 3.3.1: Definitions relating to water and space heating, and cooling:

a) **Heat:** the quality of being hot or high temperature. Heat and temperature are always used interchangeably; however, it is different.

b) **Temperature:** the measure of hotness or coldness of a substance, usually recorded in 'degrees Centigrade', written as ^{o}C, in Africa. You may also see temperature reported in degrees Fahrenheit.

c) **Heating:** the process of becoming warmer or rising temperature.

d) **Space heating:** It is the process of heating a limited area e.g. a room, by means of a heat emitting device within the area.

e) **Water heating:** Water heating is a heat transfer process that uses an energy source to heat water above its initial temperature.

f) **Uses:** typical domestic uses of hot water include cooking, cleaning, bathing, and space heating.

g) **Cooling:** the process of reducing the temperature of, e.g. a room, below ambient temperature.

h) **Air conditioning:** a system for cooling an indoor environment, most commonly using electrical power refrigeration and cook air circulation

Facilitation Step 3.3.2:

1. Ask the participants (individually or in groups) to identify which of the water, space and other heating needs we discussed in Step 3.3.1 could, and which could not, feasibly be met by the cooking fuels and technologies [refer back to Unit 3.1: Cooking if needed].
2. Lead facilitated discussion on what would be needed to address water, space and other heating needs that could not be met by the cooking fuels and technologies identified. Draw on the notes and photos in Resource 3.3.2.
3. In thinking about this question, and in addition to the goal of meeting the needs of households, keep in mind our criteria of achieving low/zero emissions, safety, efficiency, availability, and affordability.

Resource 3.3.2: Traditional and improved heating technologies and fuels:

Traditional heating stove: kerosene stoves, inefficient cookstoves burning wood, animal dung, charcoal (photo), crop wastes, and coal (although coal is not used in Kenya). In many homes, the cookstove is also used for warmth/space heating as well as for water heating, but additional stoves may also be used.

Improved water heating stoves: multi-purpose stoves, a heat exchanger (i.e. a water heater built into a stove), water heaters, kettles (requires mains power), solar water heating

Improved space heating stoves: providing warmth in the home without also producing a lot of smoke presents a challenge for most settings in Kenya, where most homes are not insulated and the costs of using modern energy (electricity, gas, etc.,) would be prohibitive for most. This is an important topic for trainers to discuss with the participants.

Charcoal Heaters

Solar water heater available in Kenya design for installation on a (flat) rooftop

Facilitation Step 3.3.3: Barriers to cleaner water and space heating

1. Exercise 3.3.1: Ask the participants (individually or in groups) to use the table provided in the Exercise (below) to (it is recommended to print the table for the groups to use):
   a. First enter the fuel and technology options identified in Facilitation Step 3.3.2 for meeting water, space, and other heating needs of households.
   b. Discuss and then record assessments of the criteria: emissions, efficiency, safety, availability and supply, and affordability.
   c. Discuss and record barriers to adoption and use, and how these barriers might be addressed.
2. Groups present their findings.
3. Lead facilitated discussion of the group's responses, drawing on the Commentary points in Exercise 3.3.1.

Exercise 3.3.1: Barriers to cleaner water and space heating

Criteria and barriers	Fuel and technology proposed by groups		
	Water heating	Space heating	Other heating
Fuel/technology (1)			
Fuel/technology (2)			
Fuel/technology (3)			
Clean: low or zero emissions			
Fuel efficient			
Good level of safety			
Available			
Reliable energy supply			
Affordable			
Barriers to adoption and use			
How barriers might be addressed			

Commentary:

Meeting these needs potentially raises additional barriers, or adds to those we have already identified for cooking (Unit 3.1) and lighting (Unit 3.2).

Energy requirements and costs: Space heating, depending on the setting, weather conditions and temperatures, may require a lot of energy. Meeting this need is unlikely to be possible using modern, clean fuels such as LPG or electricity, due to the cost. Simple, traditional solutions such as open fires and charcoal heaters may be practical and affordable, but will make substantial additional contributions to emissions, as well as presenting additional safety hazards.

Economic: Imported devices have higher costs resulting from a number of factors including potentially higher production costs, transport, import tax and VAT, etc. Cost-benefit analysis and other economic studies can show the return on investment and may be helpful in promoting growth of local production.

Socio-cultural: People are attached to traditional space heating methods, and may be reluctant to adopt what they perceive to be complicated methods, especially in their usage. Ignorance due to lack of awareness of the benefits of the use of the clean space heating technologies needs to be addressed though eduction and the media.

Potential solutions to barriers to adoption and use of improved space and water heating technologies:

- Reduced taxation on clean, safe and efficient space and water heating equipment, including solar water heating.
- Scale-up electricity coverage, particularly for use of efficient electric water heating equipment.
- Encourage local manufacturing of space heating technologies.
- Sensitization and awareness creation on improved space and water heating technology.

3.4 Harm Minimization Through Ventilation

Purpose:

To equip participants with knowledge and understanding of:

- The concept and options for ventilation, ventilation norms, and implications for the indoor environment of various kitchen designs
- The barriers to improving ventilation, and how these can be addressed.

Training objectives	By the end of this Unit, the participants should be able to: 1. Define the concept of ventilation, be aware of the different types, and the contribution of ventilation to reducing pollution and exposure. 2. Be aware of ventilation norms and impacts of various kitchen designs on the indoor environment. 3. Identify barriers limiting the uptake of improved ventilation in relation to the indoor environment and how these can be addressed.
Duration	**60** mins
Methodology	Groupwork, house diagrams (chart), mini lecture, facilitated discussion
Materials	LCD projector and laptop, chart of photos of the cookstove and fuel types, flipcharts and marker pens.
Activity	Builds on the field visit (Unit 2.5) to examine ventilation options and norms, the benefits and limitations of improved ventilation, the barriers to uptake, and how these can be overcome.

Facilitation Step 3.4.1: Ventilation norms and options for improving ventilation in the home

1. Ask the participants what they understand by ventilation and their knowledge of ventilation norms. Present the definitions provided in Resource 3.4.1, ensure understanding and answer questions.
2. Using Figure 3.4.1 (Resource 3.4.1) explain the different means of ventilating a kitchen
3. Using Figure 3.4.2 (Resource 3.4.1) explain through and cross ventilation
4. Present the definitions of a chimney, hood and pipe, flue, and forced ventilation (Resource 3.4.1)
5. Ensure understanding and answer questions

Resource 3.4.1: Ventilation definitions, norms, methods and types

Definitions

- Ventilation: is the process by which 'clean' air (normally from outside) is intentionally provided to a building and bad used air is removed.
- Ventilation norms: These are the requirements for any building in relation to ventilation e.g. size of the windows, number of windows, openable window space, door sizes, and floor sizes in relation to utilization of the room:
  - Every room should have two windows placed to provide either Cross or Through ventilation.
  - A permanent vent must be put above each window.
  - The area of the window should be at least 10% of the floor area.
  - Each opening of the window should be at least 50%.

Means of ventilation

The components of the structure of the home or kitchen that can contribute to ventilation of emissions from a stove or other source are:

- Windows
- Door(s)
- Eaves spaces
- Vents (e.g. a covered vent in the roof)

These are illustrated for a kitchen in Figure 3.4.1:

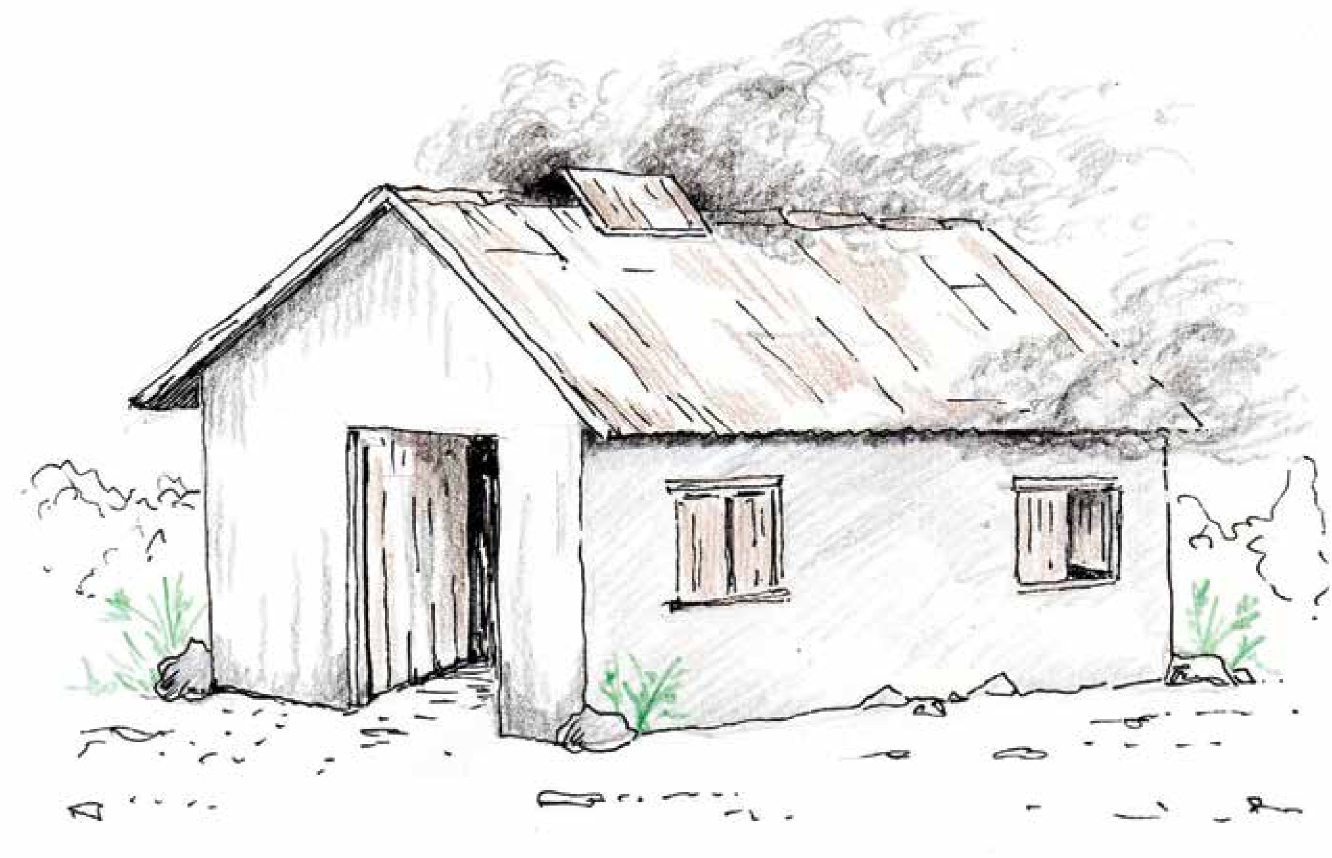


Illustration © Nigel Bruce

Building design recognizes two types of ventilation, namely **Through** and **Cross** ventilation. Through ventilation is where openable windows are placed on opposite walls. Cross ventilation is where there is an openable window on one wall and on the adjacent side. These are illustrated in Figure 3.4.2 for two common types of kitchen found in Kenya:

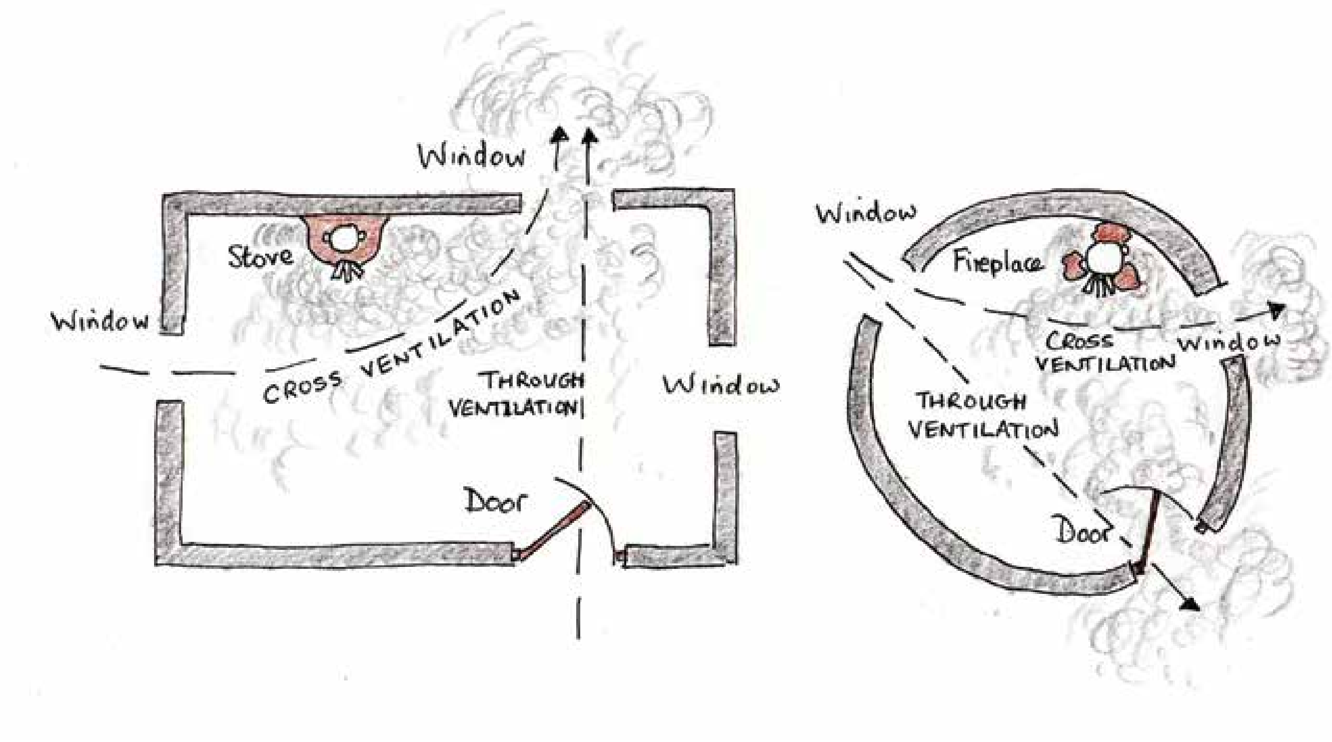


Illustration © Nigel Bruce

Direct ventilation of the emissions from the source:

Venting of emissions can also be achieved directly, or almost directly, from the source, thereby preventing much of the emitted pollutants from entering the room. As noted above, emissions vented to the exterior contribute to ambient air pollution, and can therefore re-enter the kitchen, other parts of the home, as well as affecting neighbours. We can distinguish three types of direct venting of emissions:

- **Chimney:** A chimney is built into the structure of the kitchen or home, with an opening (the fireplace) where the fire or stove sits. The chimney runs through the roof to vent emissions outside the building.
- **Hood and pipe:** A hood is similar to a chimney, but is typically made of steel and fitted after the building has been constructed. It also sits over the fire or stove to help collect and vent the emissions.
- **Flue:** A flue is a pipe attached directly to the body of the stove, then running through an exterior wall or up through the roof to vent to the outside. A flue, being attached to the stove, will typically become very hot and therefore presents a risk for burns.
- **Forced ventilation:** A fan with a vent is a commonly used method of forcing ventilation, so air is sucked into the room and forced out to the exterior. Ventilation fans are electrically powered and would normally require a grid connection.

Facilitation Step 3.4.2: How much impact can we expect from ventilation?

1. Lead facilitated discussion of what impact we can expect from ventilation on:
   a. HAP concentrations in the kitchen and home
   b. Exposure of members of the household
   c. Other impacts of household energy use
2. Use Resource 3.4.2 to ensure that all key points are covered and answer questions.

Resource 3.4.2: What can we expect from improved ventilation?

- Better ventilation in the kitchen can reduce the levels of indoor air pollution, but with a strong source of emissions such as a wood stove, it is not possible to reduce pollutants such as $PM_{2.5}$ to levels close to WHO air quality guidelines.
- Some reduction in indoor pollution levels will reduce exposure, unless the occupants spend longer indoors believing the air to be cleaner.
- Assuming there has been no change to the cookstove or other source, the total emissions are not reduced by ventilation.
- The emissions vented to the outside of the home continue to contribute to ambient air pollution, and to climate change.
- Ventilation through vents, windows, doors, and eaves spaces will not change other aspects of the performance of the technology and fuel, for example, the efficiency of combustion in a cookstove.
- Where a chimney or hood is used or a flue fitted (see definitions in Resource 3.4.1), however, these may impact on the combustion process and hence the emissions.
- Keep in mind that enhanced ventilation does not change the inherent safety of the technology and fuel.

For these reasons, ventilation – while important and useful – is not a substitute for reducing emissions at source, ideally through the use of clean fuels.

Facilitation Step 3.4.3: Kitchen designs and the home environment

1. Facilitated discussion: present the kitchen types listed in Resource 3.4.3 and ask participants about the implications for air pollution concentrations and exposure, safety and other impacts.
2. Present the key points on the indoor environment from Resource 3.4.3, covering: household environmental quality; heating and cooling; moisture and molds; and volatile organic compounds (VOCs).
3. Ensure understanding and answer questions.

Resource 3.4.3: Kitchen design the home environment

Kitchens vary greatly in terms of design, materials, and ventilation. They may be:

- Detached (from the main house) or within the main house (non-detached)
- Enclosed kitchen with solid walls and roof, although with a door and window(s) and maybe eaves spaces
- Partly open kitchen in which one or more sides of the kitchen is/are open, or it is made of materials which are very open
- Outdoor cooking: this is uncommon in Kenya, but is seen for at least part of the year in some countries, for example in Ghana or Malawi

Commentary on implications of various kitchen designs and ventilation:

- A non-detached (integral) kitchen means that emissions may more easily enter the living and sleeping areas of the home.
- Any enclosed kitchen will tend to have higher concentrations of pollutants, in turn leading to higher exposures.
- Partly open kitchens are affected by the weather conditions such as rain and wind. There is no privacy, more firewood may be consumed due to the wind, and there is greater vulnerability to accidents.
- Detached kitchens are safer for the family due to less risk from fire spreading to the living and sleeping area, and there may be reduced exposure to emissions for some members of the household.
- Although cooking outdoors might seem less polluted, studies show that exposure to cooks remains surprisingly high. Although $PM_{2.5}$ exposure is lower than when cooking in an enclosed kitchen, the levels are still well above the WHO Guideline value.
- The factors that determine the type of kitchen used include cultural practices in different parts of the country, materials, types of cookstoves, availability of fuels, socio-economic status, and types of food to be cooked.
- If emissions are not reduced at source, then the impacts on outdoor (ambient) air pollution and the climate are unchanged.

Indoor Environment: Is the chemical, physical, psychological and social environment within a human dwelling that influences the health of the person.

Household Environmental Quality (HEQ) encompasses the conditions inside a building such as air quality, lighting, thermal conditions, ergonomics, and their effects on occupants within the building.

Household pollutants include smoke from cooking devices in the house, lighting devices, tobacco smoking, and noise which may be made worse by low roofs and a small working space.

Household Environmental Quality interventions protect human health, improve quality of life, reduce stress and potential injuries. To further improve ventilation, every kitchen (even those using gas) should ideally be provided with either a chimney or a hood.

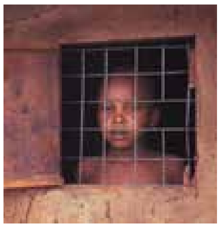
Changes in environmental temperatures and household air circulation as a result of climate change has made more people engage in weatherization/weatherproofing and ventilation. People nowadays are weatherizing (sealing and insulating) their homes and buildings to offset outdoor temperature changes as a result of climate change and to help save energy by reducing the need for heating and cooling changes. Ventilation is an important part of a building's heating and cooling system because it helps reduce indoor pollutants. Weatherizing without maintaining proper ventilation can negatively affect indoor air.

Moisture accumulates inside homes during everyday activities such as cooking, taking showers, and hanging wet laundry which increases the relative humidity level indoors. Without air ventilation, the humidity level remains high and can provide a breeding ground for mold, mites, and bacteria. Poor ventilation also can lead to increased indoor exposure to pollutants (including volatile organic compounds – VOCs – that are emitted from furnishing materials), because there is inadequate exchange with outdoor air to dilute or remove the pollutants.

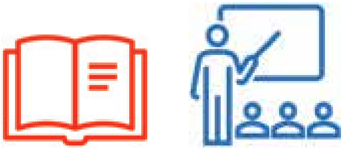
Facilitation Step 3.4.4: Barriers to improved ventilation

1. Lead a facilitated discussion using the barriers headings from Resource 3.4.4, covering:
   a. Socio-cultural
   b. Economic
   c. Technical aspects of enhancing ventilation
2. Compare and contrast the barriers and solutions with those discussed in Unit 3.1 for cleaner cooking and 3.2 for clean lighting, identifying those that are common and those which are specific to ventilation, e.g. concerns about leaks in the roof and fires (for thatched roofs) where a flue is fitted, animals entering the kitchen where ventilation is enhanced with eaves space and open windows, etc.

Resource 3.4.4: Barriers to enhanced ventilation

Topic	Barrier	How to address
Social and cultural	Privacy is valued and more open ventilation arrangements can be seen as a threat to privacy	Seek to understand feelings about privacy and associated cultural meanings and discuss as part of education about the value of ventilation
	Open windows and enlarged eaves spaces may allow animals and pests to enter the home more easily	 Wire mesh can be used allowing light to enter and smoke to leave. Mesh can also be used for eaves spaces
	Other suggested by participants:	
Economic	The cost of some ventilation options can be high, e.g. for a chimney, hood, or flue. The cost of other types of ventilation is lower but may be significant for poor families.	Include the ventilation arrangements (e.g. correctly placed windows, chimney, etc.) when the building is constructed.
	Other suggested by participants:	
Technical aspects of enhancing ventilation	Fitting a flue or chimney through the roof can cause leaks	If fitted, this must be done correctly and maintained.
	A hot flue may be, or may not be perceived to be, a fire risk for thatched buildings.	If this is genuinely a risk, great care must be taken. Spark traps should be fitted to the flue or chimney to prevent hot ash from settling on the roof or other flammable materials.
	Other suggested by participants:	

3.5 Harm Minimization (Reducing Exposure): Avoidance of Smoke, Fuel Drying, and other Measures



Purpose:

To equip participants with knowledge and understanding of harm minimization strategies through:

- Reducing exposure by avoiding smoke especially for vulnerable groups, where practicable and safe to do so.
- Reducing emissions through fuel drying and appliances that save on fuel combustion.

Training objectives	By the end of this Unit, the participant should be able to: 1. Recommend the use of simple and integrated solutions for reducing "exposure" to HAP, particularly for vulnerable groups. 2. Understand the contribution that fuel (wood) drying can make to reducing emissions, and; 3. Describe, and where appropriate recommend, other measures, including cooking aids that can reduce fuel burned (and hence emissions), e.g. hayboxes, pressure cookers, solar cookers, etc.
Duration	 **60** mins
Methodology	Video and discussion, mini lecture and facilitated discussion.
Materials	LCD projector and laptop, video, flipcharts and marker pens.
Activity	Builds on the field visit (Unit 2.5) to examine the potential for harm reduction through avoidance of exposure, and from fuel drying and other measures such as hayboxes and pressure cookers.

Facilitation Step 3.5.1: Reducing exposure by avoiding smoke

1. Show video 3.5.1. This is the same short video we discussed at the start of Unit 2.1 on health impacts. This time we will look at it from the perspective of thinking about reducing exposure by avoiding the smoke. Ask the participants to think about this for:
   a. The person(s) doing the cooking.
   b. Children, both babies/infants and older children in and around the home.
   c. People who are elderly, unwell, or otherwise vulnerable.
   d. Other members of the household.

2. Lead facilitated discussion of the participant's responses, drawing on Resource 3.5.1 to cover:
   a. Benefits and limitations of reducing exposure through smoke avoidance.
   b. Ensuring safety.
   c. That overall emissions are not reduced.

Video 3.5.1: Exposure to HAP while cooking

Resource 3.5.1: Reducing exposure by avoidance of smoke

We have seen in earlier Units, that the primary goal for prevention should be to reduce emissions at source. It was also recognized that achieving very low emissions, especially for homes in poorer, more rural locations, will take time due to issues of availability and affordability.

Furthermore, many households starting to make the transition to clean fuels may find it difficult to do so exclusively, and stacking with a mix of clean and solid fuels will mean continued high levels of emissions.

Encouraging members of the household women to avoid the kitchen and proximity to the stove when emissions are highest is one way people may be able to reduce the harm caused by exposure to HAP.

This may be especially relevant for children, pregnant women, the elderly, and the sick, with the aim of avoiding - where possible – spending time in the kitchen when cooking is taking place.

It should be emphasised, however, that *avoiding smoke is not a substitute for reducing emissions at source*. The extent to which health benefits can be gained from avoiding smoke have not been studied in any detail but is probably quite limited.

Feasibility and safety should be considered:

Avoidance of smoke may not always be practicable given cooking practices. It may also be unsafe - attention should be given to the potential dangers of a busy mother, who is also cooking, for example, no longer supervising her young children closely.

These practical issues should be considered and be part of any discussion with households about whether and how exposure to smoke can be reduced, so that the potential risks can be anticipated and managed.

Emissions are unchanged:

Behaviour changes that reduce exposure to smoke do not change the overall emissions from the stove, which are still vented to the ambient air contributing to general air pollution and climate effects.

Facilitation Step 3.5.2: Fuel drying and other ways of reducing emissions

1. Ask participants how wood fuel drying can affect emissions.
2. Lead a facilitated discussion of the group's responses, drawing on Resource 3.5.2 and emphasizing the impact of using wet wood on PM, CO, and climate-warming gas such as Methane.
3. Ask participants, in groups, to discuss other measures they can think of to reduce emissions of pollutants.
4. Facilitate discussion based on the participants' responses, drawing on Resource 3.5.2 to cover:
   a. Hayboxes
   b. Pressure cookers
   c. Solar cookers
5. Ask participants to share their own experiences and ideas to suggest any other measures for reducing emissions and/or harm; these ideas should be recorded in notes.

Resource 3.5.2: Fuel drying and other measures

Fuel drying:

Wood fuel that is wet burns less efficiently than when it is dry. Studies (for example Mitchell et al 2019 – see further reading) found that cookstoves in Africa had PM and CO emissions rates around twice as high when burning wet as compared to dry wood. The same study found that emissions of Methane, a short-acting climate-warming gas, was between 3 and 7 times higher (depending on the stove type) with the wet wood.

Ensuring that wood fuel is dry can therefore reduce the total emissions, and also the nature of those emissions, so that they are less damaging to health and the climate. Depending on the climate, availability of wood and other factors, however, households may not always have the time and capacity to dry wood fuel.

© Nigel Bruce/Practical Action

Wood fuel drying in a rack above the stove in a kitchen in western Kenya.

Hayboxes (fireless cookers):

A 'haybox' is a thermally insulated box that can be used to complete the cooking of foods that would otherwise require a long period of cooking on the stove, such as beans, stews, etc. The food is partially cooked on the stove, then placed in the haybox which maintains sufficient heat for several hours to complete the cooking.

Haybox (fireless cooker) in use at a school in South Africa.
Source: https://www.theatlantic.com/business/archive/2014/04/the-slow-cooker-that-requires-no-electricity/361343/

Pressure cookers:

Pressure cookers are a well-established technology that is widely used in many countries. By increasing the pressure of the cooking vessel, the temperature at which water boils is increased, and this in turn results in much faster cooking. They are suitable for beans and other 'hard' foods which normally require several hours of cooking on the stove with a standard pot.

Pressure cookers are very safe when used correctly, and the cost (in Kenya) is around KSh 2,500 to KSh 3,500.

Another option is the electric pressure cooker, which may be suitable where the home has a reliable electricity supply. These are more expensive, costing around KSh 6,000 to KSh 7,000.

Solar cookers:

Photo: https://www.solarcooker-at-cantinawest.com/solarcooking-howitworks.html

A solar cooker works by concentrating the heat radiation from the sun onto the pot. Experience shows that such cookers can make a useful contribution to a household's cooking energy needs, but rarely, if ever, can they provide all of the cooking energy needed.

The reasons for this include the fact that cooking often needs to be done at times of day when solar radiation is at very low levels, i.e. early in the morning, or during the evening. It may not be practical for cooking to be done during the main part of the day. Research studies show that, on average and in practice, solar cookers can contribute (at best) around 30-40% of households' cooking energy needs.

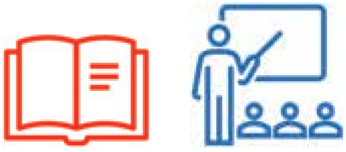
Other measures discussed by participants:

Proposed intervention	Practical issues for households

Further reading and sources:

1. Mitchell EJS, Ting Y, Allan J, Lea-Langton AR et al. Pollutant Emissions from Improved Cookstoves of the Type Used in Sub-Saharan Africa. Combustion Science and Technology, 192:8, 1582-1602. DOI: https://doi.org/10.1080/00102202.2019.1614922
2. The Slow Cooker That Requires No Electricity. https://www.theatlantic.com/business/archive/2014/04/the-slow-cooker-that-requires-no-electricity/361343/
3. An article on work with solar cookers in Kenya: Kenya learns to cook with solar power – even when the sun doesn't shine: https://www.reuters.com/article/us-kenya-solar-cooking/kenya-learns-to-cook-with-solar-power-even-when-the-sun-doesnt-shine-idUSKBN17C2KG

3.6 Tools for Supporting Change in Household Energy Technology, Fuels, and Practices



Purpose:

To equip participants with knowledge and understanding of tools and strategies for supporting households and communities in overcoming the challenges involved in the transition to cleaner household energy.

Training objectives	By the end of this unit, the participant should be able to: 1. Understand how community mapping can contribute to the assessment of needs and available resources in a community. 2. Be familiar with the 'Cost Comparison Tool', which has been designed to help households assess and compare the costs of their current cooking, lighting, heating, etc., technology and energy use with alternatives that are cleaner. 3. Use role-play to help anticipate and prepare for discussions with households about overcoming the challenges they may encounter in the transition to cleaner energy.
Duration	 120 mins
Methodology	Facilitated discussion, examples of community mapping for energy supply (urban and rural), cost comparison tool, role-play scenarios.
Materials	LCD projector and laptop, community maps (printed), recent data on energy/fuel/technology costs across selected settings in Kenya, role-play scenarios (printed) flipcharts and marker pens.
Activity	Evaluation of community mapping, application of the cost comparison tool, and role-play to anticipate challenges in supporting household in making changes to cleaner energy. One or more components of this sub-unit could be carried out as field visits if training logistics permit.

Facilitation Step 3.6.1: Mapping community energy supply

1. Ask the participants, in groups, to review and discuss the two maps (urban and rural). These are provided in Resource 3.6.1. The maps can be projected with a laptop. It may also be helpful to have printed versions (size at least A3) for groups to view and discuss in their own time.
2. Encourage groups to consider what would be involved in making these maps in their communities and record their ideas.
3. Participants should discuss and make notes on how the maps can help:
   a. Inform options for change to cleaner, more efficient, safer household energy
   b. Identify barriers, how these might be addressed, and with whom, recording their ideas
4. Ask the groups to present their ideas, and lead a facilitated discussion of their responses.

Resource 3.6.1: Mapping community energy supply

1. Rural community

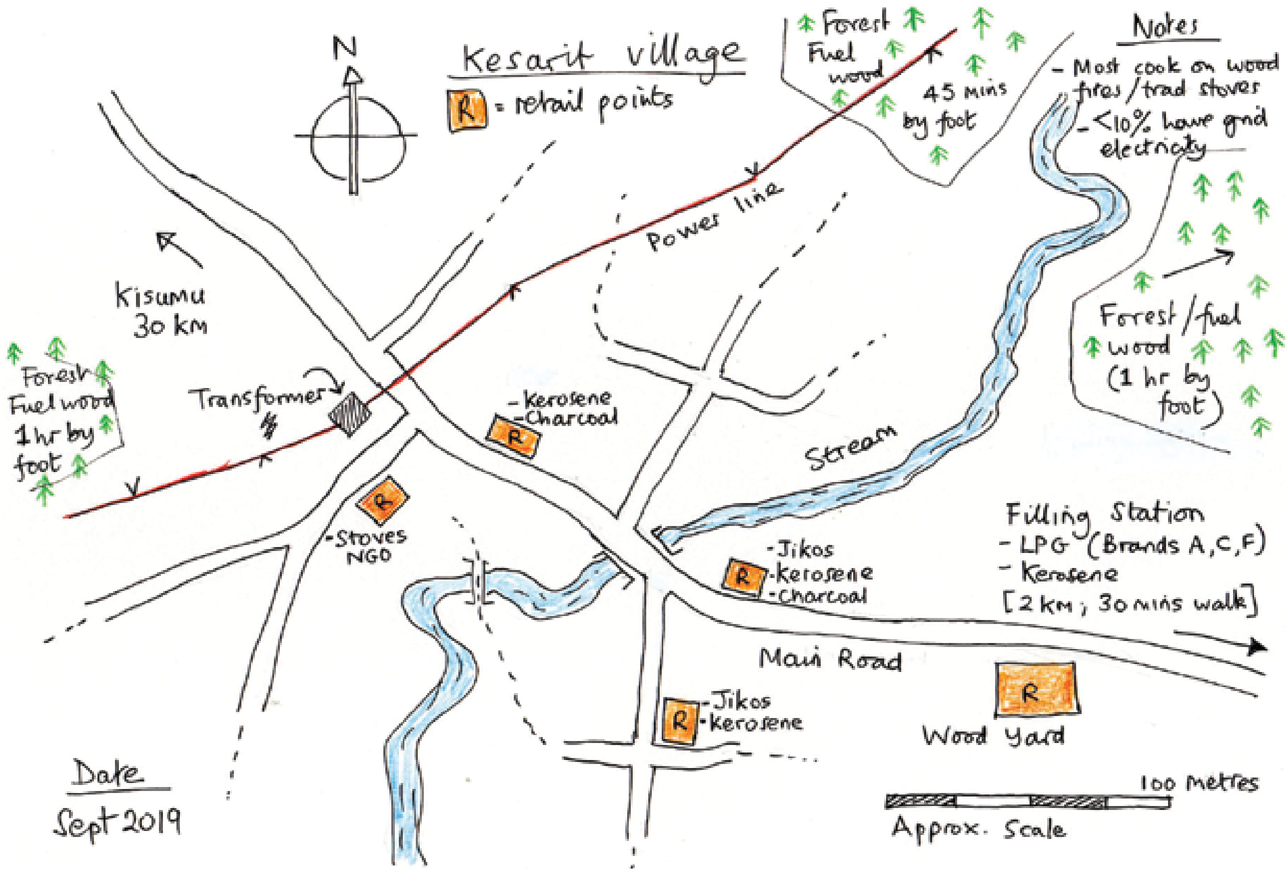


Illustration © Nigel Bruce

Additional information on the rural setting:

In the rural community, new restrictions have recently been imposed on collecting firewood in two of the three forest areas within 1-hour (return) walking distance of the village; already, many people are now buying at least some of their fuelwood.

2. Urban community

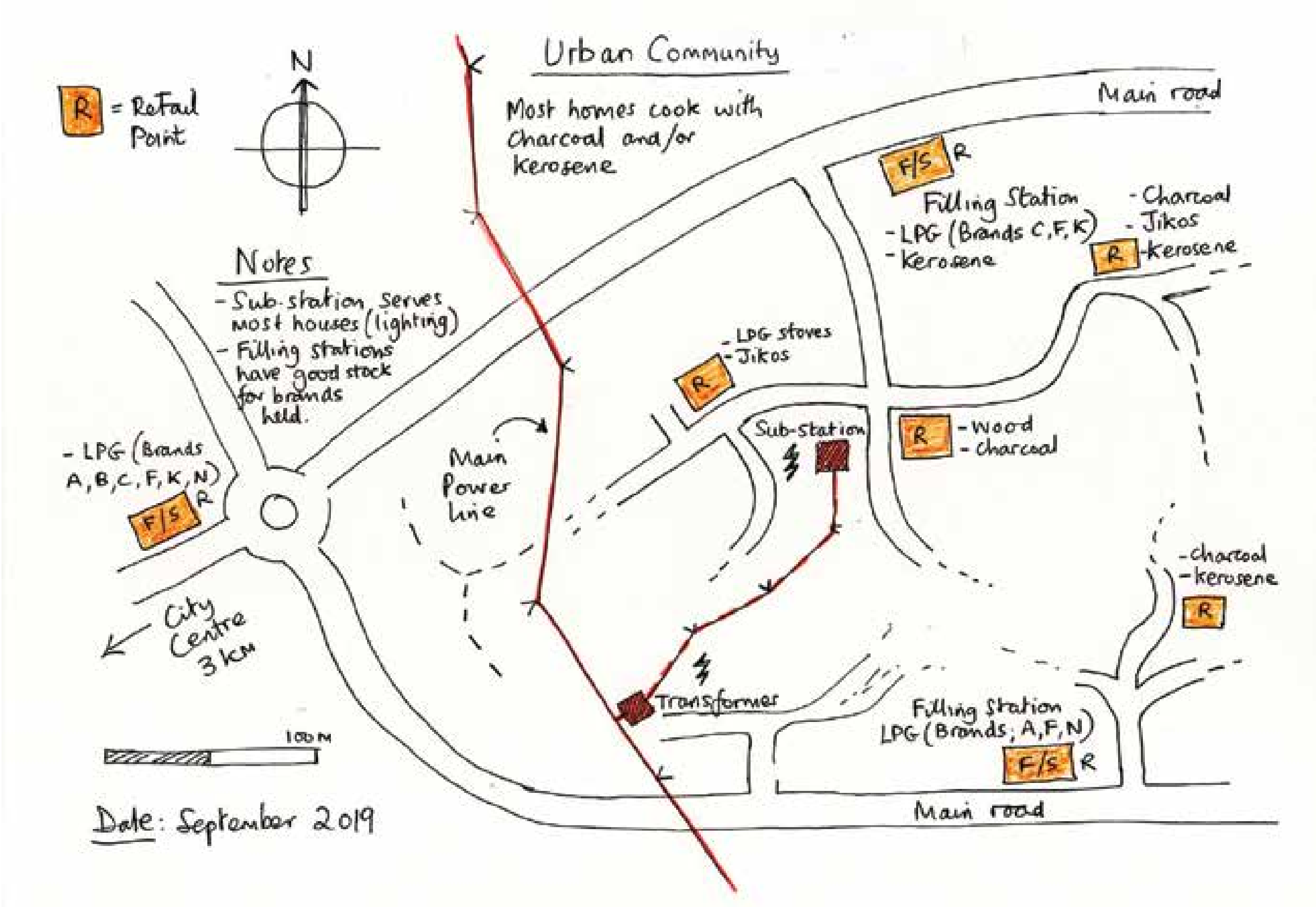


Illustration © Nigel Bruce

Additional information on the urban setting:

In the urban community, there had been two fires in the last 12 months, one did not spread to other houses, the second burned down a row of 5 homes; it is thought that both of these fires were started by users attempting to refill kerosene wick stoves during cooking.

Facilitation Step 3.6.2: Comparing costs of current and cleaner energy in the home

1. Ask the participants, in groups, to list all the main (i) cooking and (ii) lighting fuels and energy sources used in the home, then rank these in order of what they believe to be most expensive (highest rank) to least expensive (lowest rank).
2. Then ask the participant groups to present their fuel/energy cost rankings.
3. Compare these with recent data on the actual fuel/energy costs from several locations in Kenya, for example, urban and rural, and near to and remote from Nairobi.
4. Now ask the participants, in groups, to review the cost comparison tool (Resource 3.6.2) and discuss how they could use it in practice with households. The tool can be projected with the laptop, but it may also be useful to have printed copies (at least A3 size) for groups to discuss.
5. Lead a facilitated discussion on participants' perspectives on using this tool in practice, drawing on the Commentary in Resource 3.6.2 and participants' suggestions for how it could be further developed.

Note: if time and circumstances permit, this exercise could be done on field visits with the households that have given permission for the training.

Resource 3.6.2: Cost-comparison tool

This assessment of costs takes an integrated perspective on the household's energy needs. The following table includes an example of energy costs for a home currently using purchased wood and some charcoal for cooking (and water heating), and kerosene with some candles for lighting. They live in a part of Kenya where space heating is not required.

Listed here are the costs of a transition to LPG for cooking and solar lighting; water heating could be done on LPG, although this may push up the costs too much if large amounts are needed and other solutions may need to be considered if stacking (continued use of the traditional wood stove) is to be avoided.

Energy requirement	Cost item*	Current energy use (KSh/-)		Clean(er) option 1 (KSh/-)	
		Equipment	Fuel/Energy**	Equipment	Fuel/Energy**
Cooking	Primary fuel	Mud stove	Wood 250/-	LPG stove	250/-
	Acquire/replace equipment	N/A	=	1,030/-	-
	Secondary fuel	Charcoal jiko	Charcoal 100/-	N/A	-
	Acquire/replace equipment	100/-		-	-
Lighting	Primary fuel	Kerosene hurricane lamp	Kerosene 300/-	Solar lamp	[Zero]
	Acquire/replace equipment	100/-		250/-	-
	Secondary fuel	Candles	Candles 50/-	N/A	-
	Acquire/replace equipment	N/A			
Space heating	Primary fuel	N/A	-	N/A	-
	Acquire/replace equipment				
	Secondary fuel				
	Acquire/replace equipment				
Water heating	Primary fuel	Mud stove	Wood	LPG* [see note below]	150/-
	Acquire/replace equipment	N/A		[Cost covered under cooking]	
Other (specify)	Primary fuel	N/A	-	N/A	-
	Acquire/replace equipment				
Total costs		**200/-**	**700/-**	**1280/-**	**400/-**

**In this example, the costs of acquiring/replacing is the annual average over the lifetime of the equipment, with a maximum of 5 years (so if LPG start-up kit costs US$50 (5,150 KSh/-) in total, the annual cost would be 1,030 KSh/- (note that the typical lifetime of LPG equipment is 10-20 years.*

***Weekly equivalent cost of fuel*

Commentary on the cost comparison exercise:

This exercise highlights a number of issues which participants can discuss in respect of how they would manage the discussion with the household, or more widely if the issues of costs of cleaner fuel come up in community-level meetings and events:

- The equipment costs (almost entirely restricted to the initial purchase, as the need for maintenance and replacement for LPG equipment and solar lamps should be very low) would be relatively high for a family with a low income and without the ability to save or access credit. This highlights why loan and/or savings arrangements should be part of the package for change.
- Subsidies of start-up costs may also contribute; trainers should obtain up-to-date information on any relevant subsidy programmes for LPG and other clean fuels.
- On the other hand, the 'running costs' of using LPG for cooking and solar lighting are lower than for purchased wood, kerosene, and candles.
- There may be additional issues in obtaining refills for LPG, including the need for a large monthly outlay of 1000/- for a 12.5 kg cylinder necessitating some form of planning and saving, and the potential costs of transport if the house is not close to an LPG retail point.
- Recent innovations in pay-as-you-go technology could be considered, although this is currently available only in parts of Nairobi.

Facilitators can encourage the participants to adjust the figures and calculations according to their own experience and current costs.

Facilitation Step 3.6.3: Role play on identifying and addressing challenges

1. Facilitator to introduce the role-play exercise, aims and organization, and the scenarios, and ask the participants to form groups of (around) five, agreeing the roles suggested. The scenarios can be projected with the laptop, but it is recommended that these are also printed for use by the groups.
2. Groups to spend 30-40 minutes role-playing the interaction between the community health worker(s) and the household. Each group should make notes on key points of the discussion.
3. The main note-taker from each group presents on how the role play went, and the key points that arose around challenges, and how these were addressed in their discussion.
4. Lead a facilitated discussion on key learning points from the exercise.

Exercise 3.6.1: Role Play Exercise

Aims:

- This exercise is an opportunity to take an integrated approach to addressing cultural, practical, cost, and other issues involved in promoting and achieving change using Role Play.

Organisation of exercise:

Small groups of four or five participants, acting out the following roles:

1. Community Health Worker
2. Main cook in the household
3. Other members of the household (free to decide): e.g. husband/head (if not the cook), grandparent, older child.
4. Primary note-taker
5. Secondary note-taker and observer

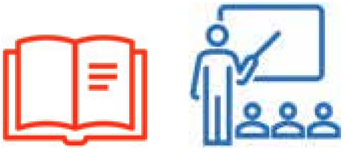
Rural role-play scenario card

- Household of six people: mother, father, three children (aged 8, 5 and 2 years), and grandmother (aged 76 and suffering from COPD). The father is an agricultural worker, and on low, seasonally variable wages. The mother earns some additional money as part of a local craft co-operative.
- They cook on a traditional mud stove, with a mixture of wood that is purchased (about half) and collected (free) from nearby woodland.
- They occasionally use a traditional charcoal stove for additional cooking needs.
- For lighting, they use two kerosene wick lamps, plus a torch using dry-cell batteries when needed.
- In the colder season, the family keeps the wood stove alight for longer for warmth
- A small amount of water is heated on the traditional wood stove each day.
- Following discussion with the CHV, the family are interested in using cleaner fuels and energy in the home, but have limited financial resources, a sick grandmother (needing visits to the local health centre and medication). They are saving a little for school fees for when the children go to secondary school. They are not sure what cleaner cooking and lighting options would be suitable and affordable.

Urban role-play scenario card

- Household of three people: young parents with an 18-month baby. The father has a steady and reasonably secure semi-skilled job in a nearby factory and is on modest wages. The mother does not work or have any other source of income.
- They cook on a kerosene stove, buying the fuel they need every two to three days from a nearby retail point.
- They also use an improved charcoal jiko stove two or three times per week for additional cooking needs, buying the fuel they need once or twice a week in quite small quantities.
- For lighting, they have a mains connection and two bulbs of 40 watts; these are not LED bulbs but old type incandescent bulbs. In addition, because of unreliable electricity supply, they have a non-pressurized kerosene lamp with a glass cover.
- If it is cold, they light the charcoal stove inside the living area of their home.
- They heat a small amount of water each day, using either the kerosene or the charcoal stove.
- Following discussion with the CHV, the family are interested in using cleaner fuels and energy in the home. They are not sure what cleaner cooking and lighting options would be suitable and affordable.

3.7 Addressing the Health and Environmental Impacts of Energy Supply and Use at an Institutional Level



Purpose:

To equip participants with knowledge and understanding of:

- The supply and use of energy in institutions linked to the work and responsibilities of Community Health Workers, and the resulting impacts on health, environment, and climate
- Their roles in respect to mitigating these impacts and addressing barriers to the use of clean and sustainable energy

Training objectives	By the end of this Unit, the participants should be able to: 1. Identify institutions in their local community for which energy use can impact on health, environment, and climate; 2. To describe the determinants of Indoor Air Quality in institutional buildings and impacts on climate change; 3. Describe their roles in respect of these institutions, working alongside CHVs, and how barriers to change can be addressed.
Duration	 **60** mins
Methodology	Groupwork, facilitated discussion, field visit to a suitable health facility or school if training logistics permit.
Materials	LCD projector and laptop, flipchart, and marker pens.
Activity	Groupwork focused on identifying the use and impacts of energy in institutions and understanding the role of Community Health Workers in facilitating change to cleaner and more sustainable energy.

Facilitation Step 3.7.1: Institutional energy supply, use and impacts

1. Ask the participants, in groups, to identify types of institution and their use of energy, focusing on:
   a. Uses of energy, e.g. cooking, heating, lighting, provision of services, etc.
   b. What sources of energy are most commonly used.
   c. Impacts of energy use (or lack of it) on health, service provision, environment (e.g. forests) and climate.
   d. Other aspects of institutional building design and construction which have implications for health.
2. Groups present their ideas.
3. Lead a facilitated discussion drawing on Resource 3.7.1, ensuring understanding and that all key topics are covered.

Resource 3.7.1: Institutional energy supply, use and impacts on health, service provision and environment

Photos © Nigel Bruce

Hospital wood stove and fuel yard, near Kisumu, Kenya.

Institutions where the adverse impacts of energy use may be within the responsibility of community health workers:

Priority:

- Health posts, health centres and hospitals
- Primary and secondary schools, colleges, and universities

Others:

- Prisons, religious buildings, social halls, children's homes
- Bars and hotels, supermarkets, etc.

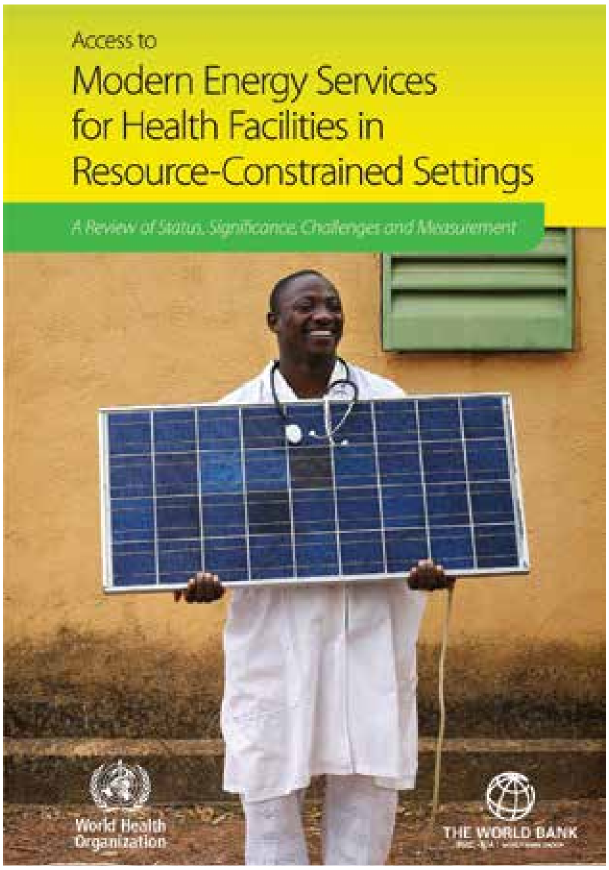
Mothers of child inpatients prepare food in a kitchen provided for their use at the hospital in Karonga, Malawi.

Use of polluting fuel

The most important impacts arise from institutional use of polluting solid fuels (and kerosene) for cooking, heating, water heating, lighting, and other uses. The emissions, adverse health impacts, and consequences for the environment (e.g. forest depletion) and climate are similar to those we have discussed for homes, but on a larger scale. The use of polluting fuels is especially important in respect of vulnerable groups in health facilities and hospitals, and for children in schools.

Lack of electricity supply

A second important issue that has rightly gained increasing attention in recent years is the lack of electricity supply in health facilities, and also in schools. Apart from providing good quality, reliable lighting, electricity is vital for many health service procedures, especially for surgery, paediatric and maternity services. In 2013, Adair-Rohani et al (WHO) published a review of studies of electricity access in health facilities in 11 sub-Saharan Africa countries, including Kenya. This showed that overall, 26% of health facilities had no access, and only 28% had reliable access.



For Kenya, 26% of facilities had no access, although this was the case for only 2% of hospitals. But only 24% of hospitals reported reliable access to electricity, and only 14% of other facilities did so. There had been an improvement in electricity access in Kenyan health facilities from 65% in 2004 to 74% in 2010, the last year of the available surveys. The data were obtained from health facility surveys; these can be referred to for more up-to-date information.

In 2015 WHO and The World Bank published 'Access to Modern Energy Services for Health Facilities in Resource-Constrained Settings: A Review of Status, Significance, Challenges and Measurement'. Facilitators may wish to draw on this report as a resource for training of CHEWs and other public health staff.

The European Union has also published material on modern energy access for health facilities, schools and water, emphasizing the linkages and impacts on health, environment and development.

Building design and impacts on health

Building design can affect health, in addition to the adverse impacts from the combustion of polluting fuels and the lack of supply of modern energy.

Indoor air quality in institutions have often been linked to poor design, construction and/or maintenance of buildings. Ventilation is a critical provision in buildings, especially in learning institutions. For example, do Carmo

Freitas et al (2011) found that classrooms facing a street had lower air pollutant levels than those facing an inner patio. This could be linked to ventilation issues as inner patios may generate less air movement and consequent accumulation of pollutants. Crowded is also important, with the density of persons per square metre being positively associated with the concentrations of air pollutants. Institutions located in basements may suffer from accumulation of pollutants, probably resulting from inadequate ventilation.

The complex hospital environment requires special attention to ensure healthy indoor air quality (IAQ) to protect patients and healthcare workers against hospital-acquired infections and occupational diseases. Poor hospital air quality may cause outbreaks of building-related illnesses such as headaches, fatigue, eye, and skin irritations, and other symptoms.

In classrooms with a higher number of windows/doors opened pollution is lower due to increased ventilation. Poor indoor air quality in institutions can be explained by insufficient ventilation, especially in cold seasons, infrequently and a large number of students in relation to room area and volume, with constant re-suspension of particles from room surfaces.

Facilitation Step 3.7.2: Towards climate-friendly institutions

1. Ask the participants to discuss and state the various elements of a climate-friendly institution
2. Lead facilitated discussion drawing on Resource 3.7.2

Resource 3.7.2: Climate-friendly institutions

Institutions, along with industry, traffic, and homes in developing countries such as Kenya emit a relatively low proportion of global climate climate-warming pollutants. As we have seen, however, there are synergies between measures taken to reduce health-damaging pollution and those taken to protect the environment and climate. This was captured in the WHO Guidelines we looked at in Unit 1. In addition, some of the environmental and climate change effects are felt locally. So, for example, forest depletion in Kenya can affect temperatures and rainfall, and vulnerability to flooding, compounding the effect of more widespread climate change. So local action is important, and this is recognised in the Kenyan government's energy strategy.

Here are some of the criteria by which the climate-friendliness of institutions in the country can be assessed:

Energy Efficiency: Monitoring and reducing institutional energy consumption and costs through efficiency and conservation measures.

Green Building Design: Building institutions that are responsive to local climate conditions and optimized for reduced energy and resource demands.

Alternative energy generation: Producing and/or consuming clean, renewable energy onsite or via the grid, while ensuring reliable and resilient operation.

Transportation: A variety of measures are possible, including:

- Using alternative fuels for institutional vehicle fleets where available.
- Encouraging walking and cycling to the facility
- Promoting staff, patient, and community use of public transport
- Siting buildings to minimize the need for staff and patient transportation.

Food: Provide sustainably grown local food for staff and patients

Waste: Reduce, re-use, recycle, compost; employ alternatives to waste incineration

Water: Conserve water; avoid bottled water when safe alternatives exist.

Facilitation Step 3.7.3: Role in work with institutions and barriers to change

1. Ask the participants, in groups, to discuss and record how they see their roles with respect to institutional energy use and impacts.
2. Groups present their ideas.
3. Lead facilitated discussion, drawing on Resource 3.7.3, on roles, barriers to change in institutions' energy use, and how to address these.

Resource 3.7.3: Role with institutions and barriers to change

Community health worker role:

The main roles of Participants, working with professional colleagues in respect of institutional energy use:

1. Creating awareness on the importance of clean, safe, efficient and sustainable energy to reduce adverse impacts on health and environment.
2. Advocating for access to reliable electricity in health facilities, schools and other priority institutional settings.
3. Giving advice on best practices with respect to cooking, heating, lighting and other energy uses to ensure institutions are free from air pollution and safety risks associated with energy use.

4. Identify institutions for which further support and cooperation with the health sector could assist changes in energy use practices.
5. Record and report data on energy use in institutions. In selected sites, measure the levels of key air pollutants in and around institutions [we will look at measurement of air pollution in Unit 4].

Barriers to change:

- **Knowledge and awareness:** Officials and others managing institutions may be unaware of the health and environmental impacts of energy use, and of the importance of electricity access in health facilities to service delivery.
- **Regulatory and institutional barriers:** Human resource shortages/capacity, community awareness, inter/intra-sectoral barriers, as well as lengthy and/or expensive approval processes.
- **Economic barriers:** Financial constraints are likely to be one of the most important perceived barriers, although more efficient and cleaner energy may be cheaper over time.

Addressing barriers:

Community health workers can contribute to addressing barriers to change by identifying potential areas for improvement and can provide colleagues and institutional managers with information and advice. While CHEWs are not in a position to directly influence regulation and finance, they can provide information by reporting data on energy use and practices, and advocate for change.

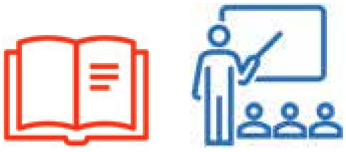
Reading Materials

1. Healthy hospitals healthy planet healthy people; addressing climate change in health care settings. Report by the World Health Organization and Healthcare without Harm.
   https://www.who.int/globalchange/publications/healthcare_settings/en/
2. Indoor Air Quality in Primary Schools (2011), By Maria do Carmo Freitas et al.
   https://www.intechopen.com/books/advanced-topics-in-environmental-health-and-air-pollution-case-studies/indoor-air-quality-in-primary-schools
3. Adair-Rohani H et al (WHO). Limited electricity access in health facilities of sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability. Global Health: Science and Practice, August 2013. DOI: 10.9745/GHSP-D-13-00037.
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4168575/
4. WHO and The World Bank. Access to Modern Energy Services for Health Facilities in Resource-Constrained Settings: A Review of Status, Significance, Challenges and Measurement.
   https://apps.who.int/iris/handle/10665/156847
5. European Commission. The role of energy services in the health, education and water sectors and cross-sectoral linkages. November 2006. ITP/0874
6. The Green Mark Standard for Green Buildings. Green Africa Foundation 2018

UNIT 4

Monitor, Evaluate and Report on Household Air Pollution

4.1 Monitoring of Household Air Pollution Indicators



Purpose:

To equip participants with knowledge and understanding of:

- The definition and purpose of indicators.
- A suitable framework for indicators designed for monitoring action to reduce the adverse impacts of household energy use.
- Sources of information for these indicators.

Training objectives	By the end of this Unit, the participants should be able to: 1. Define an indicator and its purpose in programme management. 2. Describe a suitable framework for household energy indicators based on structure, process, output, and outcome 3. Describe how data routinely collected (by CHVs) and compiled can provide the information for these indicators.
Duration	 **60** mins
Methodology	Mini lecture, facilitated discussion, reference to CHIS data collection forms.
Materials	LCD and laptop, flipcharts, marker pens, printed table of indicators (Resource 4.1.2).
Activity	Discussion of why we use indicators, description of a framework for household energy indicators and identifying sources of data including from the community health workers' information systems.

Facilitation Step 4.1.1: Definitions and a framework for household energy indicators

1. Ask the participants to state their understanding of the term *indicator*, and the purpose of indicators.
2. Present the 'structure, process, output and outcome framework'.
3. Lead facilitated discussion on the type of information that could be used for these four components of the indicator framework, drawing on Resource 4.1.1 and the Table, reminding participants that indicators must be 'realistic and measurable'
4. Present the definitions of *monitoring* and *evaluation*, drawing on Resource 4.1.1, ensure understanding and answer questions.

Resource 4.1.1: Definitions and framework for indicators

Indicators: Indicators are clues, signs, or markers that measure one aspect of a program and show how close a program is to its desired path and outcomes.

- Indicators are realistic and measurable criteria of project progress.
- They should be defined before the project starts and allow us to monitor or evaluate whether a project does what it said it would do.
- An indicator is a tool to help you to know whether your work is making a difference.
- Indicators usually describe observable changes or events which relate to the project intervention.
- They provide the evidence that something has happened – whether an output delivered, an immediate effect occurred, or a long-term change observed.
- Indicators may be *quantitative* (e.g. % homes using LPG as their primary cooking fuel, concentration of $PM_{2.5}$) or *qualitative* (e.g. perceptions about a new stove or fuel, ease of obtaining LPG refills).

An indicator framework for household energy and HAP:

A framework for indicators that describes the structure, process, outputs, and outcomes of our community health work programme on HAP can be very helpful. It provides information on the extent to which the intended procedures are actually happening in practice. It also tells us whether households and communities are making changes that will lead to improvements in outcomes such as health, safety and the environment.

Table 4.1.1 describes the type of information that can help us find out whether the four components of the framework are being achieved.

Table 4.1.1: *Information for the four components of the indicator framework*

Component	Indicator information and comments
Structure	Information on the 'facilities' available to deliver the programme, for example, the numbers of CHEWs and CHVs trained, and systems in place for collecting information on fuel use, home visits, HAP measurement, etc. Information on policy that supports the transition to clean fuels, for example, LPG pricing for start-up subsidies, would also be relevant, as would changes in policy that may be either helpful or unhelpful. Information on new CHW practices and procedures would also be relevant.
Process	Information on the activities that can bring about change, for example, visits to homes where household energy and potential changes to reduce HAP are discussed.
Output	Information on the key aspects of household energy use and how these are changing. For example, fuels and stoves being used when CHVs first visit homes in a community, then again 12 months later following efforts to support changes in household energy use. Another example could be changes in availability of LPG in a community over the same time period.
Outcome	Information on the goals of the programme, for example, improvements in health, safety, household expenditure on energy, satisfaction with the fuels and technologies being used, etc. Indicators might therefore include kitchen concentrations of $PM_{2.5}$ and levels of exposure (which can be used as a measure of health risks), rates of burns and other injuries to children, energy costs relative to household income, perceived satisfaction, etc.

Monitoring: is continuous tracking/measurement of the levels of an indicator or measurement, for example, types of fuels and stoves, or household air pollutants such as $PM_{2.5}$ or CO.

Evaluation (of programmes): Programme evaluation is a systematic method for collecting, analyzing, and using information to answer questions about projects, policies and programs, particularly about their effectiveness and efficiency.

Source: http://www.mnestudies.com/monitoring/what-indicators-and-types-indicators

Facilitation Step 4.1.2: Sources of data for indicators

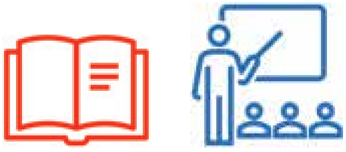
1. Ask the participants, in groups, to discuss the table from Resource 4.1.2 (it would be helpful to have this printed for ease of use by groups), which proposes sources of information for:
   a. Structure: status of the system for delivering the programme
   b. Process: activities that are intended to change household energy use
   c. Outputs: measures of household energy use
   d. Outcomes: measures that can show the extent to which the programme is having a beneficial impact on the intended goals.
2. Remind participants as they discuss the table that some of the information is in process of being added to the CHIS forms, and some other information (e.g. burns, perceived satisfaction with fuels and technology) may need to be collected separately.
3. Lead facilitated discussion, encouraging participants' own ideas for information and sources, and answer questions.

Resource 4.1.2: Sources of information for indicators

Information that could be used for indicators representing structure, process, outputs and outcomes, and sources.

Component	Indicator information and comments	Source
Structure	*Baseline data:* • Information on CHEW and CHV training across counties and CHUs. • CHW procedures and practices, and changes • Information on the CHU and households • Information on policies supporting or hindering transition to clean energy, and changes	• Ministry • MOH 513
Process	*Data from 'diary' of CHV interactions with households:* • Log of discussions with households about energy use, and • Household's stated intentions re-changing to cleaner alternatives	• MOH 514
Outputs	*Changes in energy use in the home:* • Use of energy for cooking, lighting, space and water heating • Types of fuels and technologies • Information on energy use could be added to MOH 514	• MOH 514
Outcomes	*Monitoring impacts on health risks and disease conditions:* • Presence of a pregnant woman and young child(ren) • Measurements of HAP ($PM_{2.5}$ and CO) • $PM_{2.5}$ can serve as a proxy for risk of main HAP-related diseases including ALRI, COPD, IHD, stroke, and lung cancer • Child cough in the last 2 weeks • Chronic disease (i.e. chronic respiratory disease) • Burns • Perceived satisfaction with fuels and technologies	• MOH 514 • HAP measurement • MOH 514 • MOH 100 • Some new data collection tools
	Evaluating impacts of changes in HAP exposure: To examine the relationship between measured changes in HAP exposure and specific disease outcomes such as ALRI, IHD, COPD, etc., requires complex and expensive studies. In the context of the PHC/CHW programme in Kenya, it is most useful to monitor energy use including measurement of $PM_{2.5}$ in selected sites (as described above and in Unit 4.2), and then refer to the wider research literature which is seeking to strengthen the evidence and quantify the links between exposure reduction and health improvement.	• Bespoke studies which tend to be complex and expensive

4.2 Methods for the Measurement of Household Air Pollution



Purpose:

The purpose of the unit is to equip participants with knowledge and understanding of:

- Methods and equipment for measurement of the most important and commonly used pollutants in the home, namely $PM_{2.5}$ and CO.
- Additional household information that is commonly obtained to help interpret the pollution measurements.

> Note that additional training will be provided for those participants preparing to conduct such measurement in homes in the areas for which they are responsible.

Training objectives	By the end of this Unit, the participants should be able to describe: 1. The approach to the measurement of (a) concentrations of key pollutants in and around the home, and (b) personal exposure of adults and children. 2. The types of equipment used to measure $PM_{2.5}$ and CO, and the procedures for doing so. 3. A suitable approach to selecting a set of homes for HAP measurement. 4. What additional information about the home, the household (occupants and lifestyle), energy use, etc., is usually collected to help interpret the pollution data.
Duration	 **220** mins
Methodology	Video, mini lecture, facilitated discussion, equipment and measurement demonstration, practical exercise with data collected from one or more homes.
Materials	LCD projector and laptop, video, flipcharts, marker pens, HAP measurement equipment, homes having given permission for measurement.
Activity	Gaining familiarity with equipment and procedures for the measurement of $PM_{2.5}$ and CO, participating in actual measurement in one or more kitchens and interpreting the data obtained, reviewing what additional information is required and how this can be collected.

Facilitation Step 4.2.1: Procedures and equipment for measuring HAP

1. Show Video 4.2.1 on training of participants in the measurement of HAP.
2. Present 'Principles of HAP measurement' drawing on the information in Resource 4.2.1 and showing the equipment to illustrate how this is used in practice.
3. Lead a facilitated discussion to ensure understanding and familiarity with the principles, and to answer questions.
4. Move to the home(s) designated for the HAP measurement. Demonstrate placement and initiation of measurement for $PM_{2.5}$ and CO. Allow the measurements to run for at least 30 minutes (if possible, for up to one hour) in the kitchen while discussing practical aspects of the procedure with the participants.
5. After 30 minutes (to one hour) of measurement in the kitchen, return with the equipment to the training venue, download and display the data for discussion. Refer also to the 24-hour measurements illustrated in the video and slides (described further below) to emphasise why 24-hour (or 48-hour) measurement is important in routine practice.

Video 4.2.1: Training of participants in the measurement of HAP

This short video (duration 3 minutes) shows instruction on the measurement of $PM_{2.5}$ in a heavily polluted kitchen in Langas, an urban area of Eldoret.

The video includes examples of data recorded over 24 hours in two kitchens, one using wood fuel, the other LPG. These are available in the teaching slide set and should be used during training (back in the training venue), along with the downloaded data obtained from the monitoring carried out during the training. The pollution levels are very much higher in the kitchen using wood as compared with that using LPG. This is very instructive, as is the comparison with the WHO air quality guideline level which is also illustrated on the slides.

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As noted in the video, it is important emphasise to participants that when carrying out HAP measurement as part of routine monitoring work, measurement must be carried out for 24 (or 48) hours. This is done to cover the whole daily cycle of emissions from cooking, lighting and other uses of energy in the home, as concentrations fluctuate greatly.

Resource 4.2.1: Principles measurement of HAP:

What locations should be used for measurements?

- **In the home:** measurements are made in the kitchen, and sometimes also (if resources permit) in other rooms or areas, such as living rooms and sleeping areas or rooms. For the kitchen, in particular, it is important to follow the standard procedures for where to locate the sampler; this should be at the standard distance (1.0 to 1.5 metres) from the source (stove, etc.) at around breathing height, and away from doors and windows where draughts will affect the concentrations.

- **Personal exposure:** equipment for personal exposure must be light, quiet, and non-intrusive, and especially so for children. Modern, lightweight measurement equipment, such as the PATS+ illustrated here, or the MicroPEM illustrated below, is typically placed as close as possible to the breathing area (i.e. upper chest). Local items of clothing can usually be adapted for this purpose.
- **Outside the home:** we have seen in earlier units how important it is to take account of air pollution outside, whether it is coming from the house in question, or from other homes, traffic, industry, etc. The key considerations for locating outdoor measurement equipment are that this should be protected from weather, and from damage or interference – usually, it will be held in a secure container that allows a free flow of ambient air around the monitor.


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A PATS+ device, a lightweight, light scattering particle monitor with a battery life of up to 72 hours which can easily be worn.

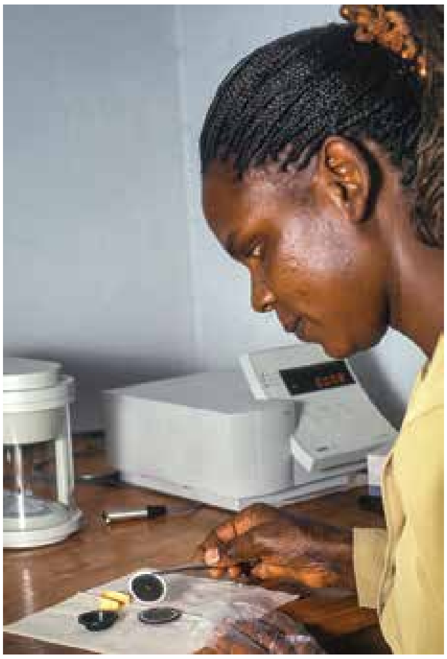
How does the equipment measure pollutants?

Different technologies are used for measuring the two most important pollutants we are interested in, namely $PM_{2.5}$ and CO.

Particulates: There are two main methods:

- The first uses a laser or other light that is shone through a chamber into which the pollutant is able to enter. The amount of ***light scattering*** detected by sensors in the instrument provides a measure of the concentration of the particulate pollutant.
- The second method, known as ***gravimetric***, is ultimately more reliable and regarded as the 'gold standard'. This involves measuring the weight of the particles that are trapped on a special filter after a known volume of air has been sucked across the filter by a pump (see further details below).
- In order to measure only those particles of a specified size, such as $PM_{2.5}$ (which are 2.5 microns in diameter, or smaller), a device known as a cyclone is used to ensure that only the $PM_{2.5}$ particles enter the measurement chamber or settle on the filter.

Devices that rely only on light scattering (such as the PATS+ monitor) need to be ***calibrated*** against the gravimetric method from time to time, to allow for the fact that the way light is scattered varies across settings, due to the properties of the pollution particles and other factors. Devices such as the MicroPEM that use a pump, also need to be calibrated to ensure the pump is sucking air at the required flow rate.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An exposed filter showing the sooty particulates from a Kenyan kitchen using a wood fuel stove, being prepared for weighing in the laboratory.

Carbon monoxide (CO): A gas such as CO is usually measured by an **electro-chemical** device; this has a sensor which changes its electrical properties in response to the concentration of CO.

From time to time, these electro-chemical devices also need to be ***calibrated***, which is done by checking the readings against a special cylinder of CO gas with a known concentration.

© Dan Pope

Equipment set-up for measuring kitchen concentrations and personal exposure to household air pollution.

MicroPEMs are being used for $PM_{2.5}$, and Lascar electro-chemical monitors for CO.

The instruments can be seen located on the wall for measuring kitchen concentrations, and in a pouch on the lady's apron for measuring personal exposure.

© Nigel Bruce

Calibrating the pump flow rate for a MicroPEM particle monitor, a small, easily worn device which includes both laser light scattering and gravimetric measurement systems.

How are emissions measured in the laboratory?

Emissions of particulates and CO during laboratory testing are measured using similar technologies, but with the addition of a special ***hood*** or ***chamber*** to collect all of the emissions from the stove.

How is stove use measured objectively?

Although it is feasible to ask the cook about stove use, it is more objective and reliable to actually measure the use of the device. This can be done by recording changes in temperature relating to the period of use of the stove, using an electronic thermometer called a ***thermocouple***. A variety of types are now available and known as 'stove use monitoring systems' or SUMS. Software is available to help define which of the recorded temperature fluctuations represent periods of use of the stove for cooking, and which are just caused by, for example, changes in temperature over the day.

How are the data recorded, downloaded, and analyzed?

All of these instruments record the data electronically, with the exception of the gravimetric method which requires a separate weighing of the filters (see below).

Data are downloaded in CSV or similar formats and can be analyzed using standard software.

Procedure for using filters with the gravimetric method:

Where filters are used, these must be weighed in standard conditions of (low) humidity before being inserted into the measurement device and exposed to the air pollution. During measurement, the air flow rate and duration are known, so the volume of air that has passed across the filter is also known.

The filters are then removed from the device and returned to the laboratory, where they are placed in the same conditions of low humidity and re-weighed on a very accurate balance.

The difference in pre-exposure and post-exposure weights provides the data on the weight of particulates collected. This weight, together with the known volume of air sampled, provides the concentration; for $PM_{2.5}$ this is usually expressed as micrograms (μg) per cubic metre of air (m^3).

For added quality control, a sub-sample of the pre-weighed filters are taken to the study site, but not exposed to pollution. These are then returned to the laboratory and re-weighed to ensure that the weight has not changed – these are called field blanks.

Similarly, some filters are kept in the laboratory and re-weighed – these are called laboratory blanks.

Facilitation Step 4.2.2: Additional information on the home

1. While at the home(s), ask the participants to look around the house(s) and kitchen(s) and think about how these, stove, lights, fuels, etc., that emit pollution are used by the occupants.
2. While at the home(s), lead a facilitated discussion on what information should be collected when measuring HAP, and how this should be done.
3. On returning to the training centre, present and discuss the additional information and data collection methods, drawing on Resource 4.2.2. Harmonize this discussion with the ideas provided by participants when at the home(s), ensure understanding and answer questions.

Resource 4.2.2: Additional information and data collection methods

Additional information:

Here is a list of some of the information that is often collected in studies measuring HAP; participants may think of other useful information:

- Household: household size (adults and children), demographic information, socio-economic resources (including household 'assets' such as radio, TV, fridge, motorbike, animals, etc.), reliability/seasonality of income, education and literacy levels.
- Energy: Available main and secondary household energy sources for cooking, lighting, space heating (if used).
- Depending on the purpose of the study, information may also be collected on the costs of fuels used, where obtained, distance to collection (e.g. forests for wood) or retail points for purchased fuels, transport needs, and options, etc.

- House construction: type of house, features including materials (mud, stone, brick, iron, thatch, etc.), of the floor, walls and roof, number of rooms.
- Dimensions of the kitchen and house (if separate), which can be used to calculate volume.
- Ventilation, including windows, doors, vents, chimneys, or flues.
- Foods cooked, and meals per day, other uses of the stove (e.g. food preparation for ale, processing such as fish drying), etc.
- Whether one or more members of the household smokes in the home, or outside.
- Information on other facilities including water treatment, sanitation, hygiene, etc., may be collected if a more complete picture of the home environment is required; this may be linked to data collection work relating to Module 7 (WASH).

Methods:

Quantitative data collection:

Most of this information can be collected through structured questionnaires by an interview with one member of the household who is best placed to provide it. Structured formats with numbered responses are known as 'quantitative' methods, and provide information that is clearly defined, and data which are relatively quick and easy to analyze. The questionnaires can be written in mobile apps, which allows the responses to be checked (via internal checks) and immediately added to the study database.

Qualitative data collection:

If the intention is also to find out more about people's opinions and experiences, qualitative 'methods' are more useful, as these allow freer expression. The common methods used for qualitative enquiries are either individual 'in-depth' interviews that are much less structured (i.e. they are allowed to flow more) or 'focus group discussions'. The responses are then usually audio-recorded and transcribed for analysis, which requires special skills to ensure that the ideas are correctly represented and summarized.

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A structured interview using a mobile phone-based application.

Facilitation Step 4.2.3: Sampling homes for HAP measurement

1. Ask the participants, in groups, to discuss and write up notes on what criteria they think would be important in selecting homes for household air pollution measurement
2. Groups present their ideas.
3. Lead facilitated discussion, drawing on Resource 4.2.3, ensuring understanding and answering questions.

Resource 4.2.3: Factors to consider in sampling homes

Sample size – how many homes? In order to provide a sufficiently precise estimate of levels of pollutants such as $PM_{2.5}$ and CO in homes, or personal exposure of occupants, samples of around 30 homes (or 30 people) are required. This will allow meaningful comparisons with samples collected from homes in other areas, or from the same area at a later date to see whether changes in household fuels and technologies have led to useful reductions in HAP.

Criteria for selecting homes: This will depend on the exact purpose of the HAP measurement. For example, if a representative sample of homes in a particular area is required, a random sampling method should be used. This might be modified if the intention is to measure HAP only in homes using a particular technology and fuel, in which case a 'census' of a larger area may be made to find out which homes are using wood, LPG, kerosene, etc., and then a random sample taken from those using the fuel of interest.

This approach can also be used if the intention is to compare, for example, homes using mainly wood with those using mainly LPG. Such a study would need samples of around 30 homes for each fuel group to allow a useful comparison.

Other selection criteria: These may include geographical area, urban or rural location, distance from supplies of fuel, etc. It is important to determine the precise objectives of the HAP measurement work before planning this, so as to ensure that the most efficient and informative sample of homes is selected.

4.3 Reporting and Interpretation of Household Energy/HAP Indicators

Purpose:

To equip participants with knowledge and skills to:

- Report Household Energy and HAP indicators to a variety of audiences.
- Provide interpretation on progress with the transition to clean, safe, efficient and sustainable household energy.

Training objectives	By the end of this Unit, the participants should be able to: • Describe the purposes of reporting on progress in the transition to clean household energy using HAP indicators. • Describe the range of approaches to reporting and their applications. • Interpret a summary report of data on household energy and HAP indicators.
Duration	**90** mins
Methodology	Mini lecture, exercise on interpretation of household energy data, facilitated discussion
Materials	LCD project and laptop, flipcharts, marker pens, printed exercise with data and report commentary.
Activity	Review of reporting approaches for household energy and HAP, and exercise on reporting and interpreting data from homes.

Facilitation Step 4.3.1: Purpose of and approach to reporting of household energy and HAP indicators

1. Ask participants, in groups, to discuss and make notes on what they know about the purposes of, and approaches to, reporting on household energy and HAP Indicators.
2. Groups present their ideas.
3. Lead facilitated discussion drawing on Resource 4.3.1; ensure understanding and answer questions.

Resource 4.3.1: Reporting on Household Energy and HAP Indicators

Purpose for reporting:

i. To ensure that the objectives of interventions are met by monitoring and measuring progress regularly to determine significant deviations from the household energy policies and strategic framework agreed by the Ministry of Health and its partners.

ii. To effectively and efficiently communicate to stakeholders the status of access to and use of clean and safer fuels, technologies, and other measures, aimed at reducing the adverse impacts of household energy use on health, safety, the environment and climate.

Methods of reporting:

There are two broad methods of reporting i.e. written and oral/visual reports

- Written reports include:
  - i. Abstract and Briefing
  - ii. Status Reports (monthly, quarterly, and annual)
  - iii. Fact Sheet
  - iv. Empirical Publication
  - v. Newsletters

- Oral or visual reports include:
  - i. Presentation
  - ii. Exhibit
  - iii. News Release
  - iv. Poster

The following tables provide generic guidance on the various types of written and oral/visual reports listed above.

1. Written Reports

Type	Use	Definition	Main Components	Tips
Abstract and Briefing	For audiences who are short on time or focus.	An abstract is a short, written overview. A briefing is a short, oral overview. Both are usually part of a larger report.	The reasons for conducting the evaluation. The major conclusions and recommendations.	If your audience is short on time, they should be able to quickly and easily glean major evaluation conclusions.
Status Reports	For audiences interested in a highly formal report on all aspects of a program and the evaluation.	A detailed, monthly, quarterly, or year-long overview of a program and evaluation findings.	Summary, background information, a description of the project, evaluation results, etc.	Status reports can be interesting and engaging if you follow a proven format.
Fact Sheet	For audiences who want to easily pick out relevant facts about the data at a glance.	Simple, one-page documents listing facts about the data in a simple-to-read format.	A brief program background, purpose, basic data, conclusions, and recommendations.	Should easily convey data at a glance.
Empirical Publication	For specific practitioners or academics who are interested in research or evaluation findings.	A publication that includes the data collected from actual research, experiments, or observations.	An empirical publication includes an abstract, introductions, literature review, methodology, results, implications, conclusions, and references.	When writing your empirical publication, use the results of any qualitative or quantitative data you collected, especially if you were able to demonstrate specific causal results from your experimental design.
Newsletters	For an audience who is interested in a program or organization, often serving as a primary link—sometimes the only link—between an audience and the program.	An informative publication that is written and distributed on a regular basis (monthly, quarterly) and contains updated information about the program or cause.	Can vary in length and contain graphics showing data results, pictures, and other items of visual interest.	Keep the distribution schedule regular so those receiving it begin to expect and look forward to receiving it.

2. Oral or visual reports

Type	Use	Definition	Main Components	Tips
Presentations	To display key presentation points in order to enhance understanding, illustrate ideas, and break down complex concepts into simpler ones.	PowerPoint is a presentation software that allows you to create slides, handouts, notes, and outlines that enhance your oral presentation. It is the most common type of public presentation.	A presentation includes a title, purpose, Training objectives, background, findings, and recommendations.	Text should be minimized on each visual by using six to eight words per line and six to eight lines per visual. Be sure your equipment works, the lighting is appropriate, and the colors and text are readable.
Exhibit	For large events like fairs or conferences. A good way to network, put information into people's hands, and create awareness among large audiences.	Display boards or an arrangement of materials and publications about your program usually set out on a table or in a booth.	Should include a title, several bulleted statements that convey your message, photographs, and/or illustrations.	Exhibits that have a gimmick are most successful at attracting an audience. "Make and take" activities, free gifts, and innovative information products are attractions that draw people to the exhibit.
News Release	To raise public interest in a study or evaluation you have conducted.	Interesting, news worthy summary that is sent to newspapers, radio, and television stations, highlighting only the most important details of your evaluation or study.	Begin with the most important information, using an eye-catching message. Use quotes by program principals or participants that draw attention to important information. Include the name, phone number, and address of a contact person so reporters can follow up and verify information.	The news release should end with "###." This symbol will alert the reporter that the news release is finished.
Posters	For advertising programs, creating awareness, and piquing the interest of people interested in the results of your study.	A visually interesting board or placard that is used to promote a single idea, event, a point, or to generate interest.	Should include the name of the program, project, research, organization, the goal of the project, the findings from the research, etc. Should also contain bright pictures, photos, and graphics along with sound bites and interactive features.	Use questions (not just statements or pictures) to initiate an interaction with people. They entice people to find out more. Different colors affect the eye differently. Bright colors can help attract attention resulting in higher response rates

Facilitation Step 4.3.2: Exercise on interpreting and reporting household energy and HAP data

1. Exercise 4.3.1: Ask the participants, in groups, to review and discuss the data in the exercise, making notes of their interpretation under the following headings:
   a. Overview and context
   b. Cooking
   c. Lighting
   d. Space and water heating
   e. Smoking and health
   f. Safety: burns and kerosene poisoning
   g. HAP: Kitchen $PM_{2.5}$ and CO
   h. Other observations
2. Groups present their notes.
3. Lead facilitated discussion drawing on the report commentary in Exercise 4.3.1; ensure understanding and answer questions.

Exercise 4.3.1: Exercise on summarizing and interpreting data on household energy use and HAP

The material for this exercise contains two parts:

Part A	Table of data for the interpretation exercise to be carried out by participants.
Part B	Commentary on the main aspects of household energy use and HAP to which the data relate, for review and facilitated discussion.

Both parts can be **printed** for easier use by the groups.

Part A: Data

This exercise considers household energy use in a semi-rural sub-location of around 2,500 homes, served by 25 CHVs and five CHEWs. The sample size of the data on energy use, health and safety was around 200 homes in each of the two years studied. The data cover the fuels and energy types used for all of the main applications in the home, although the stoves and other technologies are not included for simplicity and clarity in this exercise. Also included are selected health indicators and measurements of $PM_{2.5}$ and CO (in a sub-sample of homes — see following page). The data are presented for two time periods, one year apart (Years 1 and 2).

1. Cooking energy

Indicator	Response option	Year 1	Year 2
Cooking: main fuel (%)	Wood	65	47
	Charcoal	12	10
	kerosene	23	15
	LPG	10	28
	Total	**100**	**100**
Cooking: secondary fuel (%)	Wood	35	40
	Charcoal	35	27
	kerosene	10	8
	LPG	20	25
	Total	**100**	**100**

2. Lighting energy

Indicator	Response option	Year 1	Year 2
Lighting: main fuel (%)	Kerosene	65	42
	Mains electric	5	8
	Torch	10	5
	Solar	20	45
	Total	**100**	**100**
Lighting: secondary fuel (%)	Kerosene	25	20
	Mains electric	3	5
	Solar	10	25
	Torch	62	50
	Total	**100**	**100**

3. Space and water heating energy

Indicator	Response option	Year 1	Year 2
Space heating fuel (%)	Wood	15	12
	Charcoal	5	6
	Not used	80	82
	Total	**100**	**100**
Water heating fuel (%)	Wood	64	56
	Charcoal	14	16
	Kerosene	10	12
	LPG	12	16
	Total	**100**	**100**

4. Health and Safety

Indicator	Response option		Year 1	Year 2
Health	Tobacco smoking (%)	Indoor	25	12
		Outdoor	10	22
		No smoker	65	66
		Total	**100**	**100**
	Child: cough last 2 weeks	% reporting cough	15	12
	Adult: Chronic respiratory disease	% reporting disease	8	7
Safety	Burns and scalds (last 3 months)	% homes with burn not requiring referral	10	8
		% homes with burn requiring referral	5	3
		No burns	85	89
		Total	**100**	**100**
	Child: kerosene poisoning (last 3 months)	% homes with poisoning (all referred)	2	2

5. HAP measurements:

Measurement of HAP was carried out in a sub-sample of 30 randomly sampled homes in Year 1 and Year 2 in the same sub-location as the data shown in the previous table.

Pollutant (24-hr mean)	Indicator	Year 1	Year 2
$PM_{2.5}$ (µg/m³)	Kitchen concentration	234.0	168.0
	Standard deviation	68.0	46.0
CO (mg/m³)	Kitchen concentration	11.6	8.2
	Standard deviation	2.15	1.93

WHO Air quality guideline values:

- $PM_{2.5}$: Annual average (mean) = 10 µg/m³
- CO: 24-hour average (mean) = 7 mg/m³

Part B: Report and commentary

Issues to consider	Commentary
Overview and context	• This report is based on data collected in two successive years, from the same area. • The data are mostly from the same homes and families, allowing for some movements in and out. • These factors mean that the results for the indicators present a picture of how household energy use, HAP and some health measures have changed from one year to the next. • Data from additional years will, in time, give a more robust idea of longer-term trends and the success (or otherwise) of efforts to reduce the adverse impacts of household energy use in this county and sub-location.
Cooking: some reduction in wood use in a rural area primarily using wood fuel	**Year 1:** • A majority of homes (65%) mainly used wood, and one third (35%) used it as a secondary fuel; this means that 90% used wood fuel to some extent for cooking. • Charcoal was used by rather few (15%) as a primary fuel but around one third (35%) as a secondary fuel. • Kerosene was used by one quarter as a primary fuel, and less as a secondary one. • Encouragingly in this semi-rural area, 10% were already using LPG as their main cooking fuel, with 20% reporting some secondary use; this is encouraging because it means some homes are trying LPG, it is available, and starting to become accepted. **Year 2:** • There had been some interesting and important changes. • Although wood fuel, charcoal, and kerosene were still quite widely used, more than a quarter of homes were using LPG as their main cooking fuel, and a further 25% were using it as their secondary fuel.

Issues to consider	Commentary
Lighting	**Year 1:** • Kerosene was far and away the most common lighting fuel, used by two-thirds as the main fuel, and by a further 25% as the secondary fuel. • In this semi-rural area, mains electricity connections appear to be uncommon, with mains electric lighting used by less than 10% of homes in total. • Solar lamps are used by 20% as the main lighting method, and another 10% as the secondary method, so this technology had started to be accepted and used. **Year 2:** • Kerosene use for lighting was down to around two-thirds of homes in total. • There had been a big increase in the use of solar lamps.
Space heating	We are only reporting the main fuel used for this purpose. **Year 1:** • A majority (80%) of homes reported they did not use any fuel for space heating, and this remained similar in the following year. • This, at least, means for most homes in this area, there are no additional emissions from space heating. **Year 2:** • For those who had reported some use of space heating, wood was still the main fuel • This may indicate that households have little choice but to use solid fuels for warmth. • This question would need further enquiry, and assessment of whether other, less polluting options are available.
Water heating	We are only reporting the main fuel used for this purpose. **Year 1:** • Wood is the main water-heating fuel., • The data on water heating does not tell us how often households use energy to heat water, separately from cooking. • This would need further enquiries in order to better understand needs, energy used, and the resulting emissions. **Year 2:** • There is some reduction in wood use, and small increases in use of charcoal, kerosene, and LPG. • Households are clearly less willing to commit LPG to water heating than they are for cooking, for which we saw much larger increases in use.

Issues to consider	Commentary
Tobacco smoking and health indicators	• The percentage of smokers is almost unchanged, but a majority of those that do smoke now do so outdoors, perhaps in response to health promotion messages about reducing smoking in enclosed spaces in the home. • There has been a small reduction in the % reporting that a child had a cough in the previous two weeks: this may be a sign of health improvement following exposure reduction, but more complex study design and analysis would be required to show this with confidence. Thus, a change from 15% to 12%, with sample sizes of 200 each year, represents a reduction from 30 to 24 in actual numbers, which could be due to chance. Data from subsequent years, or a larger survey, would help determine whether the changes in energy use really are reducing this symptom in children. Nevertheless, it is a trend in the right direction. • There has been almost no change in the % adults reporting chronic respiratory disease (e.g. COPD), but we would not expect a noticeable change in chronic disease over a period as short as one year.
Burns show a small reduction in prevalence over the period (3 months)	• There is a small reduction in burns, especially those requiring referral. • This is encouraging to see, and important that the risk of burns does not appear to have increased. • The numbers of cases are small, however. Thus, the % with burns requiring referral reduced from 5% to 3% which, with sample sizes of 200 each year, is a reduction in actual numbers from 10 to 6 children. As with child cough discussed above, this reduction is a trend in the right direction but could be due to chance. Data from subsequent years (or a larger study) would help to determine whether the changes in energy use are really associated with a reduction in burns. • Additional information (on causes and circumstances) would also be needed to assess whether any real reduction is the result of the advice given and changes in fuel and technology use.
Kerosene poisoning is relatively uncommon, and prevalence unchanged	• In this semi-rural area, kerosene poisoning occurs infrequently, but it is serious when it does occur. • Despite the generally positive changes in the fuels used by homes, kerosene is still the most commonly used lighting fuel • Further enquiries should be made about the storage of kerosene and providing safety advice to parents.

Issues to consider	Commentary
Kitchen $PM_{2.5}$ average 24-hour concentration	Recall that this is a sub-sample of only 30 homes, but as these houses were randomly selected, we can reasonably assume they represent the wider community in this sub-location. **Year 1:** • The average 24-hour kitchen $PM_{2.5}$ concentration of 234.0 µg/m^3 is very high • This figure is typical for kitchens using wood fuel. **Year 2:** • The concentration of $PM_{2.5}$ has fallen to 168.0 µg/m^3 • This is still very high compared with the WHO guideline value of 10 µg/m^3 $PM_{2.5}$ (the long-term target when everyone is using clean fuels), but nevertheless a substantial reduction. • This reduction in $PM_{2.5}$ is consistent with what we have seen from the changes in fuel use towards LPG for cooking and solar lamps for lighting.
Kitchen CO average 24-hour concentration	A similar change is seen for carbon monoxide (CO). **Year 1:** • The 24-hour average CO of 11.6 mg/m^3 is typical of kitchens using wood, charcoal, and kerosene. • It is above the WHO 24-hr guideline value and therefore of concern, but not greatly so. • This level is very unlikely to result in deaths from CO toxicity in most homes, but in individual homes where maybe a charcoal heater is used inside the kitchen or living areas with doors and windows closed, there could be a risk of serious toxicity. **Year 2:** • The average CO concentration in kitchens has fallen to 8.2 mg/m^3, probably as a result of the reduction in charcoal use. • This concentration is only a little above the WHO guideline value, and an important improvement.
Ask Participants if there are other data from the CHIS forms that could contribute to this report.	*Note additional suggestions:*

NOTES

NOTES

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