ICLEI
Local Governments for Sustainability

100% RENEWABLES
CITIES & REGIONS ROADMAP

Supported by:
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CAPACITY BUILDING MODULE: CLEAN COOKING

INTRODUCTION

WHAT IS CLEAN COOKING?

WHAT IS CLEAN COOKING?

Photo credit: ENACT project

- *Tracking SDG 7: The Energy Progress Report* defines clean fuels and technologies as "**electricity, LPG, natural gas, biogas, solar, and alcohol fuels**" (IEA et al. 2020);

- … clean fuels can also be defined as **fuels that do not cause household air pollution (HAP) in homes** (CCA 2011);

- The Regulatory Indicators for Sustainable Energy (RISE) policy report - defines clean cooking solutions as **"the combination of stove technologies and fuels that have higher efficiency and/or produce lower particulate and carbon emissions levels than the current baseline in a given country**" (Foster et al. 2018);

LIMITATIONS OF THE BINARY APPROACH TO DEFINING OF CLEAN COOKING

- Historically, clean cooking has been defined by the **technical attributes** from the point of view of the environment (exposure) and efficiency of the stoves and from a **binary approach** of **having access or not having access**, **solid or non-solid**, **clean or dirty**

- To date, the SDG 7.1.2 indicator - access to clean fuels and technologies for cooking - has been measured using a proxy of whether households cook primarily with **"clean" fuels.**

- The ISO, goes beyond the efficiency and emissions attributes of the WHO's guidelines focus on indoor air quality, providing guidelines for **cookstove safety and durability**.

- The binary approach **does not**: cater for the context of the environment where cooking is taking place; accommodate progression to better technologies; enhance identifying where the most challenge is

BINARY FOCUS OF THE DEFINITION OF CLEAN COOKING

- To date, the SDG 7.1.2 indicator, access to clean fuels and technologies for cooking, has been measured using a proxy of whether households cook primarily with **“clean” fuels.**

- The approach of the ISO, goes beyond the efficiency and emissions attributes of the WHO’s guidelines focus on indoor air quality, providing guidelines for **cookstove safety and durability**. While an important step forward, the ISO approach is **technocentric** and does not integrate the cookstove user’s experience.

- The growing consensus is that measurement of access should reflect a **continuum of improvement that focuses not only on fuels, but also other attributes of the cooking system**

LIMITATIONS OF THE BINARY PERSPECTIVE

- It presumes that all non-solid fuels are clean and efficient and that all solid fuels are harmful

- It also overlooks aspects of context of the household. Cooking is not a binary activity, even at the household level. An important challenge in measuring access to cooking solutions is the phenomenon of “stacking”

- Emphasis on binary definitions has sometimes **overlooked** effective and sustainable, **improved cooking solutions** that fit local contexts.

EXAMPLES OF CLEAN COOK STOVES

Electric:

Improved biomass:

Gas-based:

Ethanol-based:

Ethanol stove

EXAMPLES OF CLEAN/MODERN FUELS FOR COOKING

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Electricity


Wood pellets

Ethanol liquid


Briquettes


Domestic biogas

LPG

Ethanol gel

CLEAN COOKING AND SDGs

CLEAN COOKING AS A KEY DRIVER OF SDG SUCCESS:

1 NO POVERTY	Clean cooking is part of basic services necessary to lead a healthy and productive life and saves households time and money.
2 ZERO HUNGER	Efficient cookstoves reduce the amount of fuel needed to cook, thus reducing the burden on families who would otherwise have to collect it, buy it, or trade their food for it.
3 GOOD HEALTH AND WELL-BEING	Reducing smoke emissions from cooking decreases the burden of disease associated with household air pollution and improves well-being, especially for women and children.
4 QUALITY EDUCATION	Children, particularly girls, are often kept out of school so that they can contribute to household tasks, like cooking and collecting fuel.
5 GENDER EQUALITY	Unpaid work, including collecting fuel and cooking, remain a major cause of gender inequality.
7 AFFORDABLE AND CLEAN ENERGY	Clean cooking is essential to addressing energy poverty and ensuring sustainable energy security for billions of people.
8 DECENT WORK AND ECONOMIC GROWTH	Energy access enables enhanced productivity and inclusive economic growth. The clean cooking sector offers many job opportunities.
11 SUSTAINABLE CITIES AND COMMUNITIES	Clean cooking addresses household and ambient air pollution, resource efficiency, and climate vulnerability.
13 CLIMATE ACTION	Up to 25% of black carbon emissions come from burning solid fuels for household energy needs. Clean cooking solutions address the most basic needs of the poor, while also delivering climate benefits.
15 LIFE ON LAND	Up to 34% of woodfuel harvested is unsustainable, contributing to forest degradation, deforestation, and climate change.

MULTI-TIER APPROACH

GOING BEYOND THE BINARY APPROACH – THE MULTI-TIER APPROACH

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- The World Bank's ESMAP program, in collaboration with Loughborough University (and multiple development partners), have developed and applied a comprehensive way of measuring progress toward access to modern cooking energy

- Its broadened, contextual definition of access, termed **Modern Energy Cooking Services (MECS),** draws on the approach of the World Bank's Multi-Tier Framework (MTF) for cooking

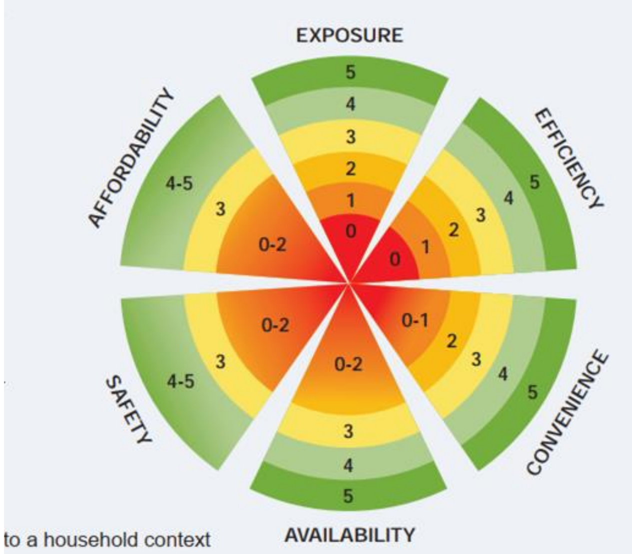
- The MTF approach goes beyond the traditional binary measurement of energy access (using or not using clean fuels in cooking)

WHAT IS THE MULTI-TIER FRAMEWORK FOR COOKING?

Source: World Bank.

- A multidimensional, tiered approach to measuring household access to cooking solutions across **six technical and contextual attributes** with detailed indicators, and **six thresholds of access**, ranging from Tier 0 (no access) to Tier 5 (full access).

IMPORTANCE OF THE MTF?



- It provides a **comprehensive and standardized way** of categorizing and measuring access to energy across different populations and geographic regions.
- Enables policymakers, researchers, and other stakeholders to **compare and track progress** towards universal energy access goals more accurately.
- Understanding contextual households level impacts

THE MULTI-TIER FRAMEWORK

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- The MTF attempts to capture the **multi-dimensional nature** of energy access and the vast range of technologies and sources that can provide energy access, while accounting for the wide differences in user experience.

- **The framework allows for disaggregate and aggregate analyses** that can yield detailed information about various parameters and indexes that facilitate comparison over time and across geographic areas.

- it enables tracking of progress toward access to MECS (to complement the current approach of tracking SDG 7.1.2.3), while also providing sufficient detail for understanding contextual household-level impact and setting sector-wide aspirations.

DRIVERS OF THE MTF FOR COOKING

The MTF for cooking highlights how a household's cooking context is driven by **technological, cultural and market factors**.

Technology driven factors:

- Exposure
- Efficiency

Cultural driven factors:

- Safety
- Convenience

Market driven factors:

- Affordability
- Availability

KEY ATTRIBUTES OF THE MTF FOR COOKING:


Photo credit: ENACT project

- Affordability
- Convenience
- Availability
- Accessibility
- Safety
- Exposure
- Efficiency

KEY ATTRIBUTES OF THE MTF FOR COOKING - DEFINITIONS:

Exposure	Exposure refers to personal exposure to pollutants, which depends on stove emissions and ventilation
Fuel Efficiency	Fuel efficiency refers to product of combustion efficiency and heat transfer efficiency
Safety	Safety refers to severity of injuries caused by the fuel
Convenience	Convenience refers to time spent in collecting or purchasing fuel and preparing the stove
Affordability	Affordability refers to share of household budget spent on the fuel
Availability	Availability refers to readiness of the fuel when needed by the user

EXPOSURE

- Exposure refers to **personal exposure to pollutants, which depends on stove emissions and ventilation**
- The key parameters that determine the cooking-exposure tiers are: 1) **stove/fuel emission factor, 2) ventilation level, and 3) contact time**.
- The health impacts from household air pollution (HAP) linked to traditional cooking activities have been a key driver of promoting clean and efficient cooking. **PM2.5 and carbon monoxide (CO) emissions** are considered key marker pollutants for exposure to HAP
- According to WHO guidelines for indoor air quality, the average **annual $PM_{2.5}$** concentration should be **lower than 10 µg per m3**, and the **24-hour exposure to CO concentration** should be **less than 7 µg per m3** (WHO 2014).
- For ventilation level, following the approach used in ISO 2018, the MTF uses proxy questions to estimate three ventilation scenarios: (i) high, (ii) average/default, and (iii) low.

EFFICIENCY

- **Fuel efficiency refers to product of combustion efficiency and heat transfer efficiency**
  - Fuel efficiency may be defined as the amount of energy released per unit mass of the fuel.
  - Heat transfer efficiency is **the ratio of the useful output heat energy transfer to the total input heat energy transfer**.

- The MTF follows the cookstove efficiency tiers in ISO 2018.

- The cookstove efficiency is estimated using existing lab tests from the country, following ISO 19867-1 harmonized laboratory-testing protocols.

SAFETY

- **Safety refers to severity of injuries caused by the fuel**
- The degree of safety risk can vary by type of cookstove and fuel used.

- Risks may include exposure to hot surfaces, fire, or potential for fuel splatter.

- In the MTF, reported incidences of past injury and/or fire are used to proxy safety

CONVENIENCE

- **Convenience refers to time spent in collecting or purchasing fuel, and preparing the stove**

- In the MTF, convenience is proxied by the amount of time necessary to collect the fuel and prepare the stove for cooking.

- It is a key consideration from the user's perspective and has high gender impacts.

AFFORDABILITY

- **Affordability refers to share of household budget spent on the fuel**

- If a large share of household income (expenditure) is required for cooking fuel, then other elements of cooking solutions (e.g., safety, health, and convenience) may be constrained.

- To determine affordability, the MTF utilizes a levelized cost-of-cooking solution as a share of household expenditures.

AVAILABILITY

- **Availability refers to readiness of the fuel when needed by the user**

- A given fuel’s availability can affect the regularity of its use. Constraints to availability can come in the form of seasonality, especially for types of fuel (e.g., wood); market supply shortages (e.g., LPG cylinders); or limited, grid-connected electricity supply (e.g., manifested in blackouts).

- Shortages in fuel availability can cause households to resort to using inferior, secondary fuel types. The MTF uses the household’s reporting on primary fuel availability for the previous 12 months.

MTF ATTRIBUTES USED TO MEASURE THE STATE OF ACCESS TO MECS

Performance-based technical attributes that shape most definitions of ‘clean’ cooking solutions

+

Attributes critical to understanding the household user’s cooking context

=

Assessment of MECS access across the six attributes

Source: ESMAP

USING THE MULTI-TIER FRAMEWORK (MTF)

MULTI-TIER FRAMEWORK FOR COOKING

- Each of these attributes are scored across 6 tiers (0 to 5).
- A score of zero is low performance and score of 5 indicate high performance
- **Meeting tier 4 across all dimensions is required to refer to a household cooking solution as modern and clean**

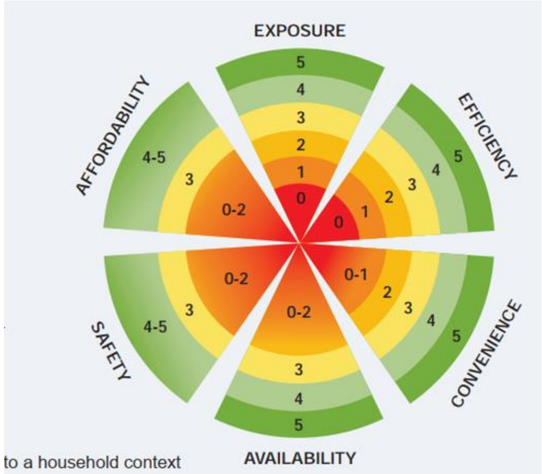
TIER STRUCTURE OF THE MTF FOR COOKING:

SYMBOL	WORDS	EXAMPLE
>	greater than	10 > 3
<	less than	2 < 6

Attribute	*Measurement indicators*	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Exposure	ISO's voluntary performance targets on emissions-default ventilation $PM_{2.5}$ (mg/MJd) CO (g/MJd)	> 1030 > 18.3	≤ 1030 ≤ 18.3	≤ 481 ≤ 11.5	≤ 218 ≤ 7.2	≤ 62 ≤ 4.4	≤ 5 ≤ 3.0
	High ventilation $PM_{2.5}$ (mg/MJd) CO (g/MJd)	> 1489 > 26.9	≤ 1489 ≤ 26.9	≤ 733 ≤ 16.0	≤ 321 ≤ 10.3	≤ 92 ≤ 6.2	≤ 7 ≤ 4.4
	Low ventilation $PM_{2.5}$ (mg/MJd) CO (g/MJd)	> 550 > 9.9	≤ 550 ≤ 9.9	≤ 252 ≤ 5.5	≤ 115 ≤ 3.7	≤32 ≤ 2.2	≤ 2 ≤ 1.4
Efficiency	Stove efficiency, using ISO's voluntary performance targets (%)	<10	≥ 10	≥ 20	≥ 30	≥ 40	≥ 50
Convenience	Fuel acquisition and preparation time (hours/week)	≥ 7		< 7	< 3	< 1.5	< 0.5
	Stove preparation time (minutes/meal)	≥ 10			<10	< 5	< 2
Safety	Severity of accidents caused by the stove over the past year	Serious			Minor	None	
Affordability	Fuel cost as a share of household expenditure (%)	≥ 10			< 10	< 5	
Availability	Ready availability of primary fuel when needed (% of the year)	≤ 80			> 80	> 90	100

Source: The World Bank

KEY DEFINITIONS RELATED TO THE MTF FOR COOKING



Source: World Bank.

- **Clean cooking solutions:** Fuel-stove combinations that achieve <u>emissions performance measurements</u> (Exposure and efficiency) of Tier 4 and above

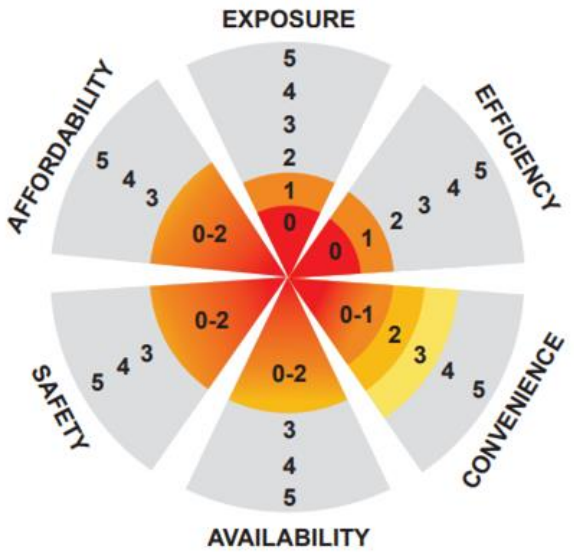
- **Modern Energy Cooking Services** (MECS): A household context that has met at least the standards of Tier 4 or higher across all six measurement attributes of the MTF

- **Improved Cooking Services:** A household context that has met at least the Tier 2 standards of the MTF across all six measurement attributes of the MTF, <u>but not all for Tier 4 or higher</u>
- Household in **transition:** A household context with a status of MTF Tier 2 or Tier 3 (lower than tier 4)

ILLUSTRATIVE EXAMPLES OF USING THE MTF

Because this household scores Tiers 0–3 across the six attributes of the MTF, it cannot be considered to have gained access to MECS.

a. Household using mainly readily-available, purchased biomass with a traditional stove

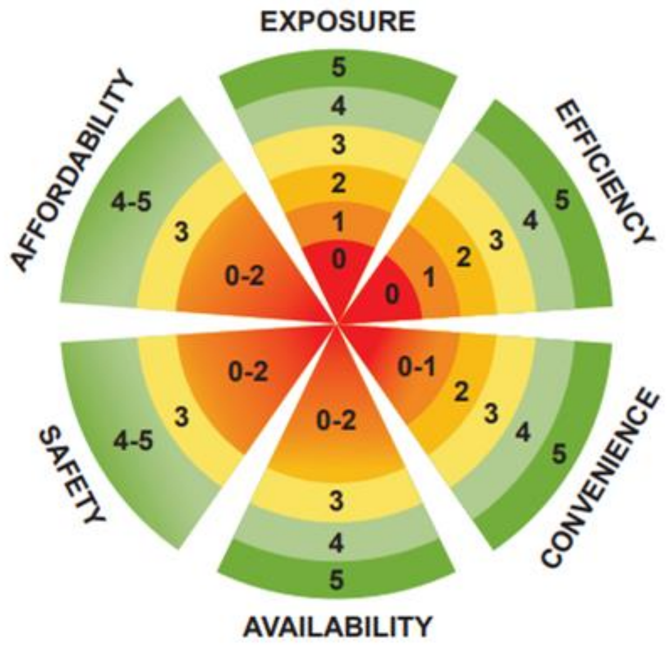


Source: World Bank.

ILLUSTRATIVE EXAMPLES OF USING THE MTF

This highly efficient electric cookstove used by this household, with relatively reliable electricity and affordable tariffs crosses at least the Tier 4 threshold across all six attributes and thus meets the MECS criteria.

b. Household using cheap, relatively-reliable grid power, with a high-performing electric cookstove



MAIN SECTORS AFFECTED BY TRADITIONAL COOKING

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PART 1

HEALTH IMPACTS

COOKING IN URBAN SETTINGS

HOUSEHOLD AIR POLLUTION (HAP)

- Smoke from biomass fuels (wood, charcoal, dung, crop residues) burned in open fires or unclean cook stoves
- Smoke from kerosene lamps
- Tobacco smoke
- Substances produced include Carbon Monoxide (CO), Particulate Matter (PM), Nitrogen dioxide (NO_2)

(Wood combustion contributes to both indoor and outdoor air pollution. Known as $PM_{2.5}$, fine particulate matter is smaller than 2.5 micrometers (µm) in size. Its small size allows the pollutants to penetrate into the deep lungs.)

In urban settings, smoke from cooking activities in homes, streets, corridors, etc.., goes into the atmosphere, thus affecting the occupants

OUTDOOR AND INDOOR EXPOSURE, CONCENTRATION SOURCES

We spend 80-90% time indoors, especially;

- Newborn
- Elderly
- Disabled
- Sick people
- Pregnant and breast feeding mothers.

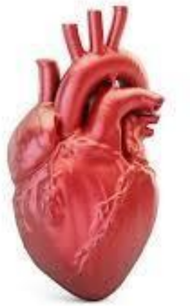
INDOOR AIR QUALITY DEPENDS ON:

- Interaction between building and its outside environment.
- The way the building is used.
- Behavior of its occupants.
- Air conditioning system.

HAP AND HUMAN HEALTH

- Inhalation of smoke from the unclean stoves and fuels →into the lungs → the blood vessels to the rest of the body.

- Effects: Immediate and long term damage – usually invisible until late stages



EFFECTS ACROSS THE LIFE COURSE

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Pregnancy/unborn baby: **compromises placental blood flow;** **direct effect on the baby**	• Bleeding (antepartum hemorrhage) • Pre-eclampsia (high blood pressure) • Low birth weight • Premature births • Poor lung function at birth
Lungs	• Increased risk of lung diseases- pneumonia, asthma, chronic pulmonary obstructive disease (COPD), lung cancer, mucosal reactions, chronic bronchitis, upper airways inflammatory disease.
Heart	• Cardiovascular disease-myocardial infarction/heart attacks
Brain	• Poor neurocognitive functioning • Stroke
Eyes	• Cataracts, ocular reactions

UNDER-RECOGNIZED EFFECTS OF HAP

HAP is associated with **higher risk** of:

- Burns especially in children
- Poisoning and girls suffer most affected
- Disability
- Discomfort.
- Odour perception
- Sensorial irritation
- Annoyance.
- Sick building syndrome
- Intoxication
- Lost opportunities (money and time costs)
- Mortality.

AIR POLLUTION IS A SILENT KILLER

About 2.4 billion people worldwide (1/3 of the global population) cook using open fires or inefficient stoves

In 2020, HAP was responsible for

- estimated 3.2 million deaths
- more than 237 000 of the deaths of children under the age of 5.

Women and children are disproportionately affected because they are typically responsible for household chores such as cooking and collecting firewood.

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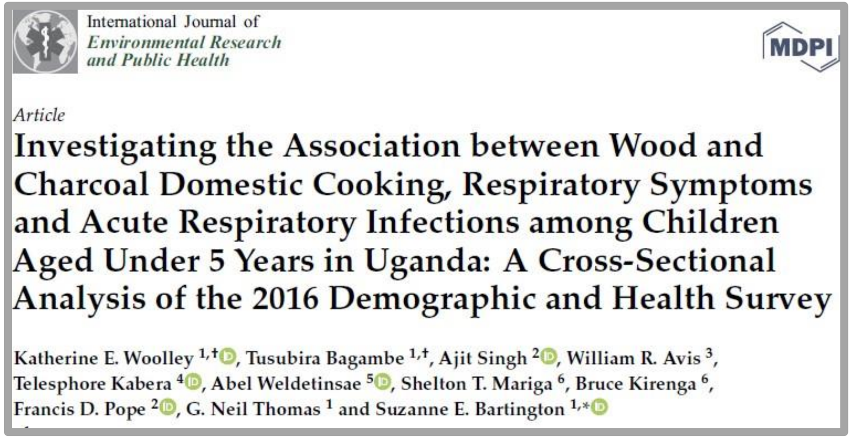
ACUTE RESPIRATORY INFECTIONS (ARI) IN CHILDREN

- Shortness of breath was significantly associated with cooking fuel type

  increased risk associated with wood fuel compared to charcoal cooking.

- In urban areas, shortness of breath was reported among 18.9% of children in wood fuel households compared to 1.09% in charcoal fuel households

  wood fuel increased the risk of shortness of breath



International Journal of *Environmental Research and Public Health*

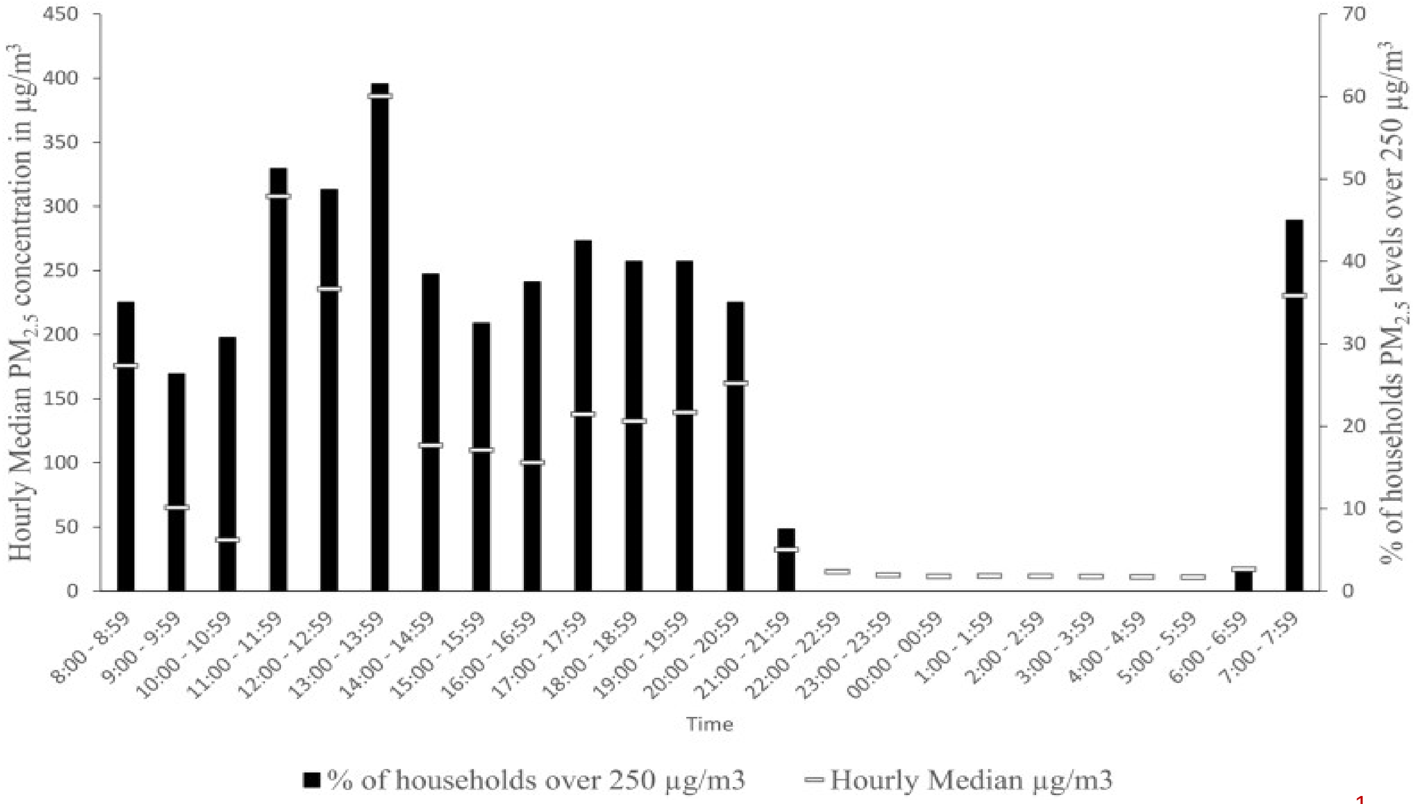
MDPI

Article

Investigating the Association between Wood and Charcoal Domestic Cooking, Respiratory Symptoms and Acute Respiratory Infections among Children Aged Under 5 Years in Uganda: A Cross-Sectional Analysis of the 2016 Demographic and Health Survey

Katherine E. Woolley [1,†], Tusubira Bagambe [1,†], Ajit Singh [2], William R. Avis [3], Telesphore Kabera [4], Abel Weldetinsae [5], Shelton T. Mariga [6], Bruce Kirenga [6], Francis D. Pope [2], G. Neil Thomas [1] and Suzanne E. Bartington [1,*]

HOUSEHOLD AIR POLLUTION PATTERNS



Source: Okello G, et.al 2019

CONCLUSION

- HAP is a major problem especially in LMICs (Low or middle income countries).
- It is a development issues, linked to poverty, health and gender
- Progress towards reduction of the health impact of HAP has been made but it is very slow
- Efforts to increase access to clean and sustainable energy especially among the poor and vulnerable populations need to be urgently accelerated.
- Raising public awareness and providing information to the public about the sources nature and level of risks of traditional cooking methods and its disadvantage in comparison with the use of renewable energy sources will be of great benefit to their health.

PART 2

GENDER INEQUALITY

GENDER INEQUALITY

Photo credit: ENACT project

Women, especially in the developing world are disproportionately affected by the adverse impacts of traditional biomass cooking as they are often tasked with most household cooking responsibility.

TIME POVERTY

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- Women and girls spend significant amounts of time collecting fuel and cooking over polluting stoves, which reduces the time they have for other activities, including education, leisure and income generation.

- Women's aggregate time loss across **fuel collection, cooking with traditional biomass cookstoves, and related fuel-preparation and food-processing activities** translates into **2–8 hours of effort per day** or about 5 hours a day on average.

HEALTH AND SAFETY

- Women and girls are particularly vulnerable to the health impacts of indoor HAP, as they spend a significant amount of time cooking and caring for family members.
- … hence more exposed to the risk of respiratory diseases, burns, eye irritation etc.
- Exposed to heightened risk of injury and physical & sexual violence while collecting wood
- Young children, who tend to stay close to their mothers indoors, also suffer a disproportionate share of the negative health risks.

Missed opportunities

Photo credit: Freepik

- Lack of access to clean cooking fuels and technologies can **limit women's economic opportunities** and increase their poverty.
- Many children, especially girls, in households without access to clean cooking are often **taken out of school** to help collect fuel and supported other cooking-related activities

PART 3

CLIMATE IMPACTS

GHG EMISSIONS

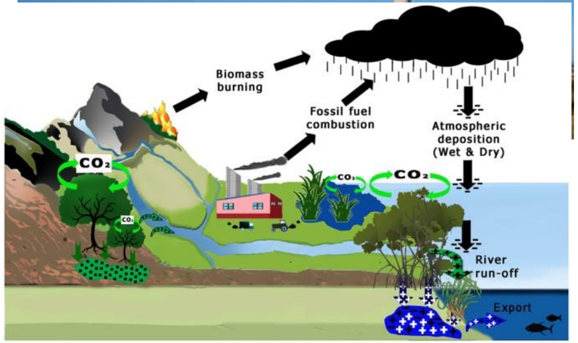

Photo credit: ENACT project

- Traditional cooking methods are often **inefficient and waste energy**, leading to higher levels of emissions and decreased energy security for communities.

- Large scale consumption of wood & charcoal **produces GHG emissions [**incl. carbon dioxide (CO_2) and methane (CH_4)], contributing to global warming and climate change.

- Globally, emissions from non-renewable wood fuel consumption amount to **1.9 to 2.3% of global CO_2 emissions**

BLACK CARBON



- **Black carbon (BC)** (and other particles of incomplete combustion from cooking with non-clean fuels) play a more significant role than CO_2 in anthropogenic global warming.

- The burning of residential solid fuels accounts for up to **58% of global BC** emissions (CCAC 2019). Reducing BC emissions could act as a near-term lever to address global warming and the health benefits of their removal from household environments

CLIMATE CHANGE

The pollutants and emissions from use of traditional wood and charcoal for cooking contributes to global warming, and hence climate change,

… which then causes water and heat stress, drought, flooding, un-predictable rain-fall patterns, reduced agricultural production etc.

PART 4

ENVIRONMENTAL IMPACTS

ENVIRONMENT

- Effects on the environment come in mainly two forms:
  - **deforestation and forest degradation**
  - **air pollution:** the incomplete combustion of fuelwood which **pollutes the air** and contributes to global warming

- Others:
  - Biodiversity loss
  - Climate change
  - Landslides and flooding

DEFORESTATION AND FOREST DEGRADATION

- Increased demand for firewood for cooking contributes to deforestation, which not only **exacerbates climate change** but also affects the livelihoods of local communities and the ecosystems they depend on.

- Continued extraction of wood from the forest leaves once closed forest systems turned into shrub lands.

- In Africa, wood collection and the charcoal supply chain are the principal drivers of regional forest degradation, jointly accounting for **48%** (Hosonuma et al. 2012)

AIR POLLUTION

- Inefficient cookstoves **produce toxic smoke (pollutants)** that pollute the air and is harmful to both the environment and human health.
- Incomplete combustion of the wood fuels, especially in poorly ventilated rooms is a key risk factor in **respiratory diseases.**
- incomplete combustion produce gases that **contribute to global warming** and there remains less trees to absorb the toxic substance that pollute the air

BIODIVERSITY LOSS

- Biodiversity loss is an attendant result of removal of wood species for use as fuel.
- There is a **reduction in the variety of wood species** composition in the forest cover.
- The habitat of fauna (animals) is eventually disturbed and leads to **loss or extinction of particular animals**
- Biodiversity loss further **denudes the land cover** through exposure to the wind, sun and fire and **affects agriculture**

NEGATIVE IMPACTS OF TRADITIONAL COOKING TECHNOLOGIES: A SUMMARY

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Health

- Chronic respiratory disease
- Acute lower respiratory infections
- Lung cancer
- Cardiovascular disease
- Childhood pneumonia
- Severe burns and injury

Gender

- More exposure to HAP
- burns from traditional cooking
- physical and sexual violence, injury during fuel collection
- time poverty
- Missed opportunities

Climate

- Greenhouse gases
- Catalytic warming effects of black carbon emissions

Environment

- Forest degradation
- Localised deforestation
- Foregone agricultural productivity due to habitat degradation

Others

- Lost opportunities (time poverty)
- Poorer nutrition
- Increased poverty
- Soot-darkened home

THE COST OF INACTION

- Without meeting the clean cooking target under SDG7 (7.1.2), the cost of inaction—driven by negative externalities for health, gender, and climate would total **US$2.4 trillion per year.**

- **The health-impact** portion results from quantifying the deaths and disability-adjusted life years (DALYs) linked to household air pollution (HAP) produced by stoves and fuels.

- **The gender cost**, assumes that women may spend up to **six hours per day** performing cooking-related tasks

- The **climate-impact cost** is driven by the dollar value of carbon prices and the social cost of carbon.

THE COST OF INACTION

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Health cost

1.4 trillion USD per year

- Quantification of premature death, disability adjusted life years resulting from biomass/ unclean cook stoves
- HAP related deaths

Gender cost

0.8 trillion USD per year

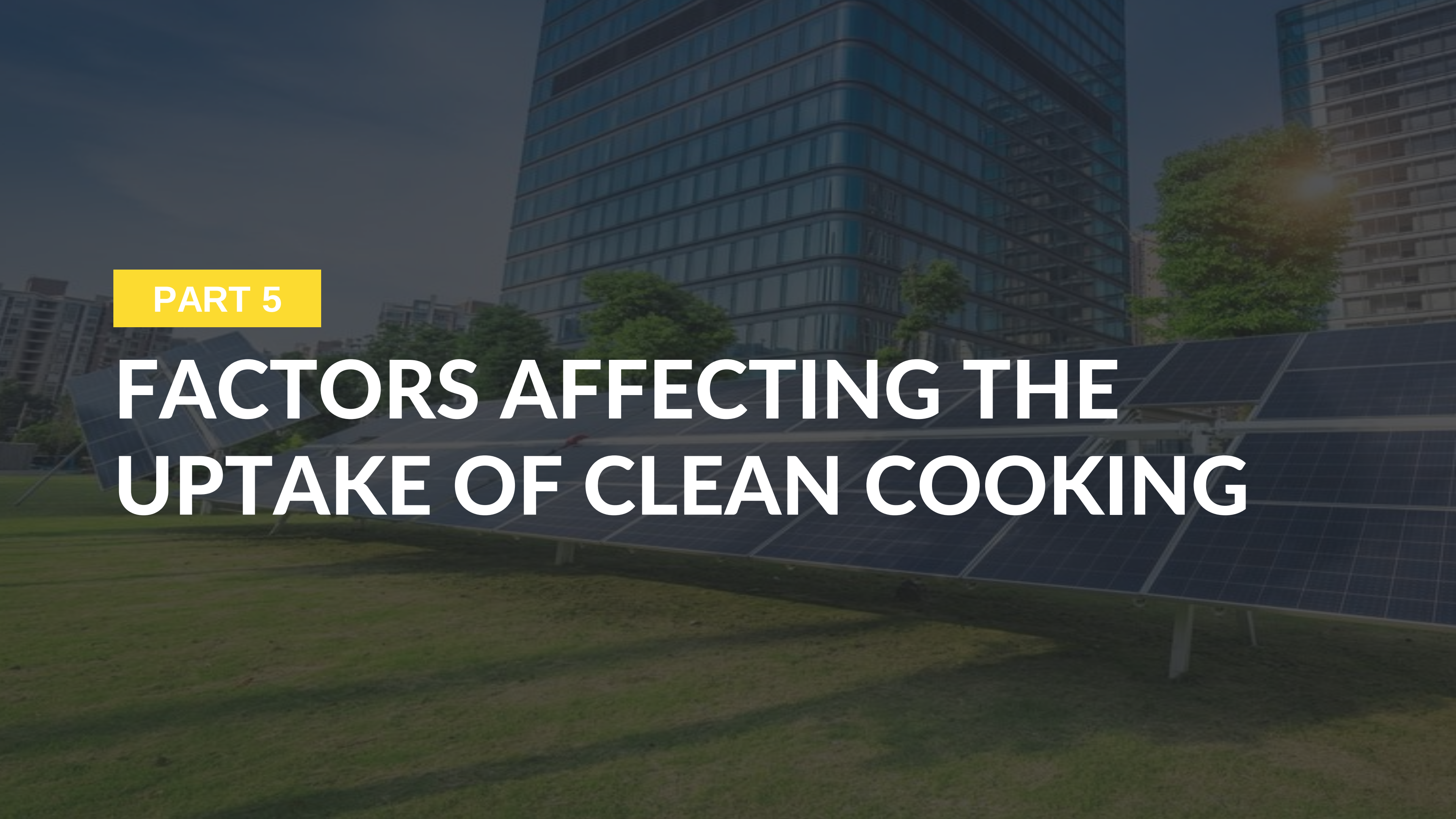
Cost of sustaining the status quo:

- assumes that women lose up to **6 hours per day** performing cooking related task
- multiplied by a conservative cost estimate of women's time

Climate & Environment cost

USD 0.2 trillion

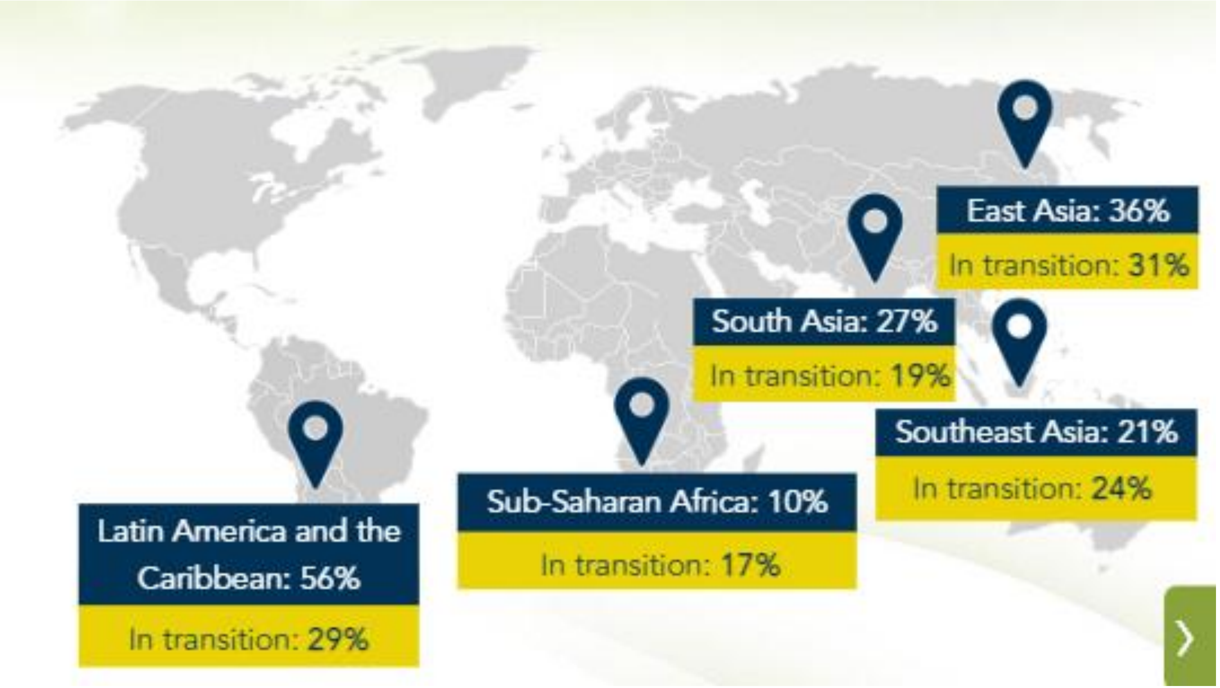
- Driven by the dollar value of carbon prices and the social cost of carbon



PART 5

FACTORS AFFECTING THE UPTAKE OF CLEAN COOKING

UPTAKE OF MODERN ENERGY COOKING



- Significant regional differences in uptake, with SSA having the lowest adoption rates.
- Those in transition meet Tier 2 of the MTF, and require more support to move up the clean cooking ladder.
- Transitions are often governed by stacking.

STACKING IN COOKING

Stacking: The use of multiple stove and fuel combinations within the same household.

- For example, a family using an LPG stove for boiling water in the morning and wood stove for cooking lunch in the afternoon.
- Prevalent particularly in urban & peri-urban settings with diverse cooking options.
- Households in urban settings that practice stacking tend to do so with the next-cleaner fuel.

STACKING IN COOKING

- **Clean stacking:** occurs when a household normally uses non-clean system (wood), but occasionally uses cleaner options, e.g., pellets.

- **Dirty stacking:** occurs when a household normally uses modern stove fuel solution, but occasionally cooks with a more polluting stove/fuel combination, e.g., charcoal, 3-stone fire, etc.

STACKING IN COOKING

- In general, using multiple cooking solutions in parallel often reduces the health benefits of a clean primary cooking solution…

…but the effect depends on the type of stacking.

- With **dirty stacking**, households that have met the threshold for primary clean-fuel access continue to face substantial exposure to household air pollution (HAP) linked to their secondary use of traditional stoves and fuels.

- **Clean stacking** represents less use of a non-clean cooking solution, which could potentially facilitate greater adoption of clean fuels over time, leading to gradually less exposure of the household to HAP.

BARRIERS TO CLEAN COOKING

- Low awareness regarding clean cooking technologies
- High upfront costs of clean cooking technologies;
- Lack of access to finance
- Lack of standards/ low adoption of standards for clean cooking technologies;
- High cost of alternatives to charcoal/ firewood
- Limited number of technicians to repair clean cooking technologies.

KEY ACCESS & USABILITY FACTORS

Clean and modern cooking adoption

Affordability: The complex interaction between the quantity of energy consumed, its price per unit, and the ability of the user to pay.

Availability: Readiness of fuel at all times when needed.

Safety: Possible injury during use and is determined based on an evaluation of the stove design.

Convenience: The overall time and effort involved in the process of securing and processing energy for cooking.

AFFORDABILITY

Higher-income quintiles are more likely to afford access to clean and modern cooking solutions.

- Compared to urban users, rural users tend to spend less on fuel, mainly due to the prevalence of wood that can be freely collected.
- In urban settings, where households are less likely to have access to readily available, free fuel sources, a larger proportion of their income must be allocated to cooking energy

AFFORDABILITY

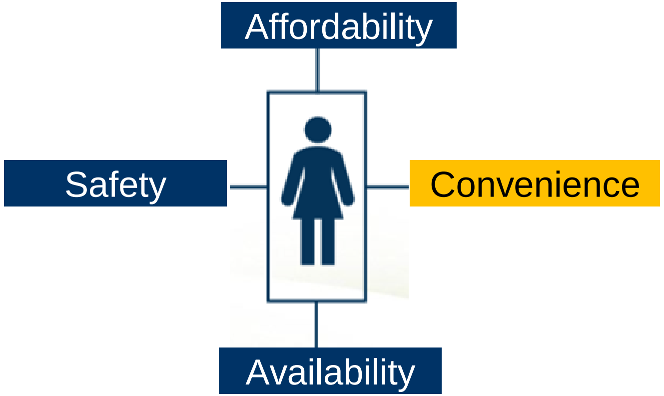
- While it is difficult to compete with the unit economics of households that do not pay for fuel, the remaining and more immediate addressable market of fuel payers is large and growing.

- The affordability challenge is especially problematic where the high up-front costs of appliances and fuels severely limit the potential for the bottom half of the market.

POTENTIAL SOLUTIONS TO AFFORDABILITY

- Price competitiveness of clean and modern cooking in terms of trends.
- Innovative financing options using MOMO systems such as PAYG.
- Electricity could be more affordable in the near future.
- Enabling environment are needed to drive affordability too, e.g., long-standing fuel subsidies and national programs that impact end-user prices.

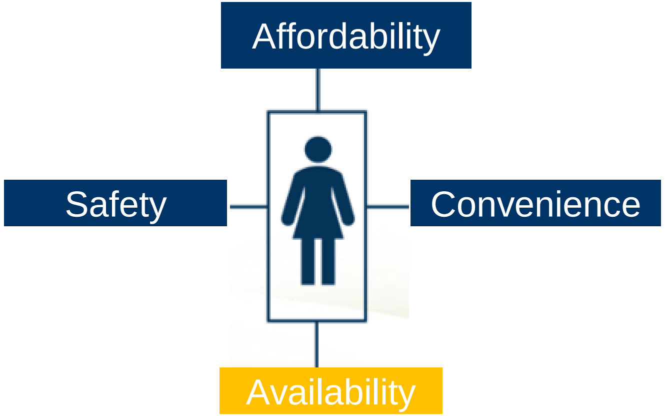
CONVENIENCE



Stove preparation time is a principal reason for adoption of clean and modern cooking.

- Average stove preparation time for users of electricity, LPG, and biogas fuels is generally lower than that of charcoal or wood users, especially in urban settings.
- Cooking time also plays a crucial part in adoption of clean cooking solutions electricity and LPG for primary use.
- Less cooking time, in some cases, may equate to less energy consumed, which, in turn, may equate to lower average expenditure and higher affordability.

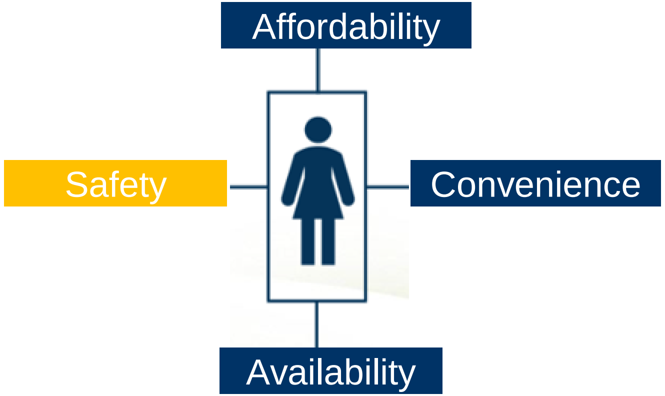
AVAILABILITY



Availability factors can be key drivers of fuel-stacking, particularly when accounting for seasonality and supply-chain volatility.

- For example, a localized study in Mexico finds that, in some contexts, stove stacking using fuelwood is driven by seasonal LPG shortages (Ruiz-Mercado and Masera 2015).
- Results of this study reinforce the importance of accounting for availability factors in understanding a household's energy use, even if a household's primary fuel source is a clean cooking solution.

SAFETY



- While fuels like LPG have often faced uptake challenges due to perceptions of safety risks, selected country data indicate that the use of LPG, electricity and other clean fuels, has generally resulted in a lower incidence of serious impacts (e.g., physical injury, illness, or death), as well as less-serious ones (e.g., fires without injury, itchy/watery eyes, or light coughing).
- MTF household data analysis from Cambodia and Nigeria highlight that approximately 2 to 4% of primary LPG-using households, on average, report either serious or minor injuries, compared to an average of 7to 14% of households using mainly charcoal or wood.

CREATING AN ENABLING ENVIRONMENT

POLICY

Photo credit: ENACT project

- **Low policy prioritization to improve and expand clean cooking, despite the high social and economic opportunity costs of inaction:** To date, policies, cross-sectoral plans, and public investments have struggled to catalyze large amounts of private financing due to unclear national-scale clean cooking policies, strategies, and targets.
- **Limited intergovernmental co-ordination:** To foster truly holistic solutions requiring participation across multiple sectors, ranging from energy, health, climate, industry, and finance to rural and urban development, gender, and social protection, among others
- **Underdeveloped infrastructure:** Limited access to clean fuel sources and the absence of supply chain infrastructure make it difficult to distribute clean cooking solutions to underserved areas.
- **High taxes and misaligned tariff codes**, particularly in market stages, hinder industry growth, e.g., making it especially difficult to import fuel-production equipment, quality stoves and components, and clean fuels.

SOCIO-CULTURAL

Photo credit: ENACT project

- **Awareness:** Many people in Africa are not aware of the health and environmental benefits of clean cooking and the options available to them.
- **Cultural and social norms:** In some African countries, traditional cooking methods are deeply ingrained in cultural and social norms.
- **Political instability and conflict:** Political instability and conflict in some African countries can hinder the implementation of clean cooking programs and limit access to clean cooking solutions.

ECONOMIC

Photo credit: ENACT project

- **Manufacturing and distribution challenges:** It is difficult to find businesses that have reached volumes that enable economies of scale. In Sub-Saharan Africa, for example, only 15 alternative biofuel businesses (e.g., ethanol and pellets)—less than 18% of the estimated active number at 2018—consistently supply more than 5,000 households with cooking fuel.
- **Inadequate financial capital to fully commit to scaled clean cooking promotion:** SEforALL estimates that funding commitments for high-impact countries for residential clean cooking have decreased, falling from nearly US$120 million to US$32 million in, as of 2019.
- **End-user affordability:** The upfront costs of technologies, and the ongoing costs of fuel sources can be expensive to end-users, making it difficult for low-income households to adopt.

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END OF MODULE

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Module developed by: Carine Buma, Azizat Gbadegesin, Sayuri Chetty— ICLEI Africa
Design: Emilia Avila Castro — ICLEI World Secretariat
Contributors: Kanak Gokarn — ICLEI World Secretariat