ASHES Webinar Series Presents:

CLEAN HOUSEHOLD ENERGY SOLUTIONS: WORLD HEALTH ORGANIZATION'S NEW TOOLKIT

Brought to you by: Colorado State University and Berkeley Air Monitoring Group

BERKELEY AIR MONITORING GROUP

Colorado State University

Our Expert Panelists Include:

Jessica Lewis is a Technical Officer in the Air Quality and Health Unit at WHO

Michael Johnson is the Technical Director at Berkeley Air Monitoring Group

Richard Ebong is the Chief Executive Officer and Co-founder at E-WEL International Consult Limited and Manager of Legal Metrology at the Uganda National Bureau of Standards

Want to learn more?

See our website and join the conversation at *ashes-csu.org*

CLEAN HOUSEHOLD ENERGY SOLUTIONS: WORLD HEALTH ORGANIZATION'S NEW TOOLKIT

Colorado State University & Berkeley Air Monitoring Group
ashes-csu.org, erhs_ashes@mail.colostate.edu

Colorado State University

BERKELEY AIR MONITORING GROUP

Opening Remarks by John Mitchell

Image shared by Michael Johnson

Advancing Sustainable Household Energy Solutions (ASHES)

Images shared by Michael Johnson

ASHES Interdisciplinary Research Highlight: Results from the STOVES Study

Acute Effects on Blood Pressure Following Controlled Exposure to Cookstove Air Pollution in the STOVES Study

Kristen M. Fedak, PhD[1]; Nicholas Good, PhD[1]; Ethan S. Walker, MPH[1]; John Balmes, MD[2]; Robert D. Brook, MD[3]; Maggie L. Clark, PhD[1]; Tom Cole-Hunter, PhD[1,4]; Robert Devlin, PhD[5]; Christian L'Orange, PhD[6]; Gary Luckasen, MD[7]; John Mehaffy, MS[6]; Rhiannon Shelton, MPH[1]; Ander Wilson, PhD[8]; John Volckens, PhD[6]; Jennifer L. Peel, PhD[*,1]

Background— Exposure to air pollution from solid fuel used in residential cookstoves is considered a leading environmental risk factor for disease globally, but evidence for this relationship is largely extrapolated from literature on smoking, secondhand smoke, and ambient fine particulate matter ($PM_{2.5}$).

Methods and Results— We conducted a controlled human-exposure study (STOVES [the Subclinical Tests on Volunteers Exposed to Smoke] Study) to investigate acute responses in blood pressure following exposure to air pollution emissions from cookstove technologies. Forty-eight healthy adults received 2-hour exposures to 5 cookstove treatments (three stone fire, rocket elbow, fan rocket elbow, gasifier, and liquefied petroleum gas), spanning $PM_{2.5}$ concentrations from 10 to 500 μg/m^3, and a filtered air control (0 μg/m^3). Thirty minutes after exposure, systolic pressure was lower for the three stone fire treatment (500 μg/m^3 $PM_{2.5}$) compared with the control (−2.3 mm Hg; 95% CI, −4.5 to −0.1) and suggestively lower for the gasifier (35 μg/m^3 $PM_{2.5}$; −1.8 mm Hg; 95% CI, −4.0 to 0.4). No differences were observed at 3 hours after exposure; however, at 24 hours after exposure, mean systolic pressure was 2 to 3 mm Hg higher for all treatments compared with control except for the rocket elbow stove. No differences were observed in diastolic pressure for any time point or treatment.

https://www.ahajournals.org/doi/pdf/10.1161/JAHA.119.012246

A recent peer-reviewed article out of CSU from the Subclinical Tests on Volunteers Exposed to Smoke (STOVES) study. Led by Drs Jennifer Peel and John Volckens.

ASHES Interdisciplinary Research Highlight: Results from the Honduras Cookstove Project

Exposure to household air pollution from biomass cookstoves and blood pressure among women in rural Honduras: A cross-sectional study

Bonnie N Young [1], Maggie L Clark [1], Sarah Rajkumar [1], Megan L Benka-Coker [1 2], Annette Bachand [1], Robert D Brook [3], Tracy L Nelson [4], John Volckens [1 5], Stephen J Reynolds [1 6], Christian L'Orange [5], Nicholas Good [1], Kirsten Koehler [7], Sebastian Africano [8], Anibal B Osorto Pinel [8 9], Jennifer L Peel [1]

Affiliations + expand

PMID: 30195255 PMCID: PMC6301093 DOI: 10.1111/ina.12507

Free PMC article

Abstract

Growing evidence links household air pollution exposure from biomass cookstoves with elevated blood pressure. We assessed cross-sectional associations of 24-hour mean concentrations of personal and kitchen fine particulate matter ($PM_{2.5}$), black carbon (BC), and stove type with blood pressure, adjusting for confounders, among 147 women using traditional or cleaner-burning Justa stoves in Honduras. We investigated effect modification by age and body mass index. Traditional stove users had mean (standard deviation) personal and kitchen 24-hour $PM_{2.5}$ concentrations of 126 μg/m^3 (77) and 360 μg/m^3 (374), while Justa stove users' exposures were 66 μg/m^3 (38) and 137 μg/m^3 (194), respectively. BC concentrations were similarly lower among Justa stove users.

https://pubmed.ncbi.nlm.nih.gov/30195255/

Honduras Cookstove Project, 2014-2018. Led by Drs Maggie Clark and Jennifer Peel and research scientists, Drs Sarah Rajkumar and Bonnie Young. Photo by Bonnie Young.

ASHES Interdisciplinary Research Highlight: Results from the HAPIN Trial

Air Pollutant Exposure and Stove Use Assessment Methods for the Household Air Pollution Intervention Network (HAPIN) Trial

Michael A. Johnson,[1] Kyle Steenland,[2] Ricardo Piedrahita,[1] Maggie L. Clark,[3] Ajay Pillarisetti,[2] Kalpana Balakrishnan,[4] Jennifer L. Peel,[3] Luke P. Naeher,[5] Jiawen Liao,[2] Daniel Wilson,[6] Jeremy Sarnat,[2] Lindsay J. Underhill,[7] Vanessa Burrowes,[7] John P. McCracken,[8] Ghislaine Rosa,[9] Joshua Rosenthal,[10] Sankar Sambandam,[4] Oscar de Leon,[7] Miles A. Kirby,[2] Katherine Kearns,[4] William Checkley,[7] Thomas Clasen,[2] and HAPIN Investigators

[1]Berkeley Air Monitoring Group, Berkeley, California, USA
[2]Gangarosa Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, Georgia, USA
[3]Department of Environmental and Radiological Health Sciences, Colorado State University, Fort Collins, Colorado, USA
[4]Department of Environmental Health Engineering, ICMR Center for Advanced Research on Air Quality, Climate and Health, Sri Ramachandra Institute for Higher Education and Research (Deemed University), Chennai, India
[5]Department of Environmental Health Science, College of Public Health, University of Georgia, Athens, Georgia, USA
[6]Geocene, Vallejo, California, USA
[7]Division of Pulmonary and Critical Care, School of Medicine, Johns Hopkins University, Baltimore, Maryland, USA
[8]Center for Health Studies, Universidad del Valle de Guatemala, Guatemala City, Guatemala
[9]Department of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, London, UK
[10]Division of Epidemiology and Population Studies, Fogarty International Center, National Institutes of Health, Bethesda, Maryland, USA

Background: High quality personal exposure data is fundamental to understanding the health implications of household energy interventions, interpreting analyses across assigned study arms, and characterizing exposure–response relationships for household air pollution. This paper describes the exposure data collection for the Household Air Pollution Intervention Network (HAPIN), a multicountry randomized controlled trial of liquefied petroleum gas stoves and fuel among 3,200 households in India, Rwanda, Guatemala, and Peru.

https://ehp.niehs.nih.gov/doi/full/10.1289/EHP6422

Household Air Pollution Intervention Network (HAPIN) Trial and RCT intervention setup in Rwanda (2018). Photo by Bonnie Young.

Webinar Control Panel

Minimize and maximize control panel

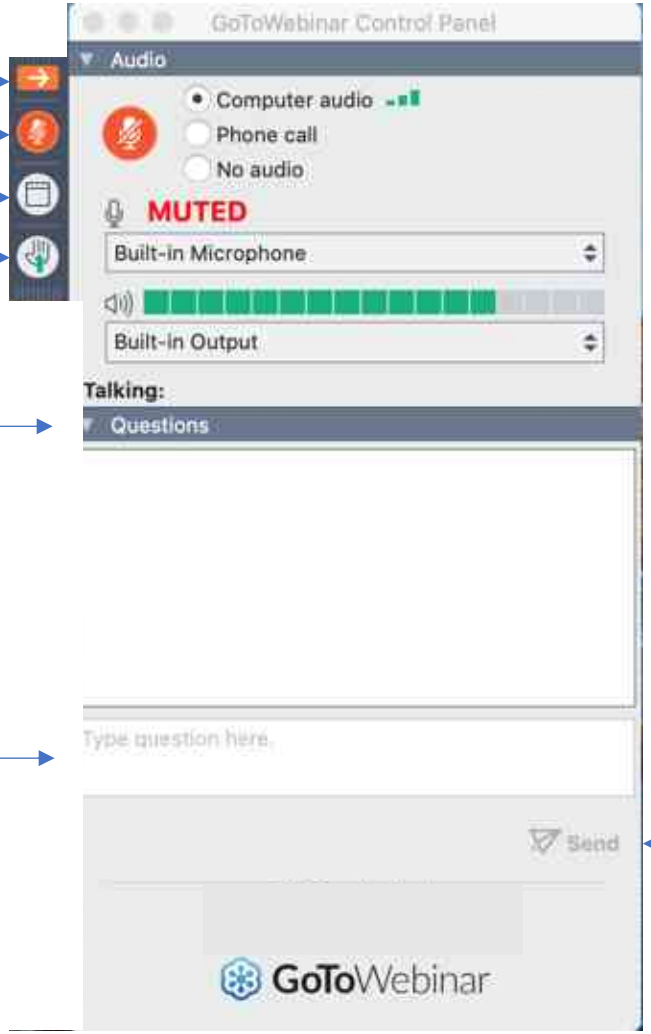
You are in 'listen only' mode

Minimize and maximize screen

We are not using this function today.

Questions pane

Type your question in here



Submit your question by clicking here

World Health Organization

Clean Household Energy for Health

Jessica Lewis

householdenergy@who.int

Overview of Presentation

World Health Organization

01 Defining household air pollution

02 Health impacts of household energy use

03 WHO Guidelines and defining clean household energy

04 WHO Clean Household Energy Solutions Toolkit

05 Setting Voluntary Performance Targets (VPTs)

World Health Organization

Defining Household Air Pollution

Defining household air pollution (HAP)

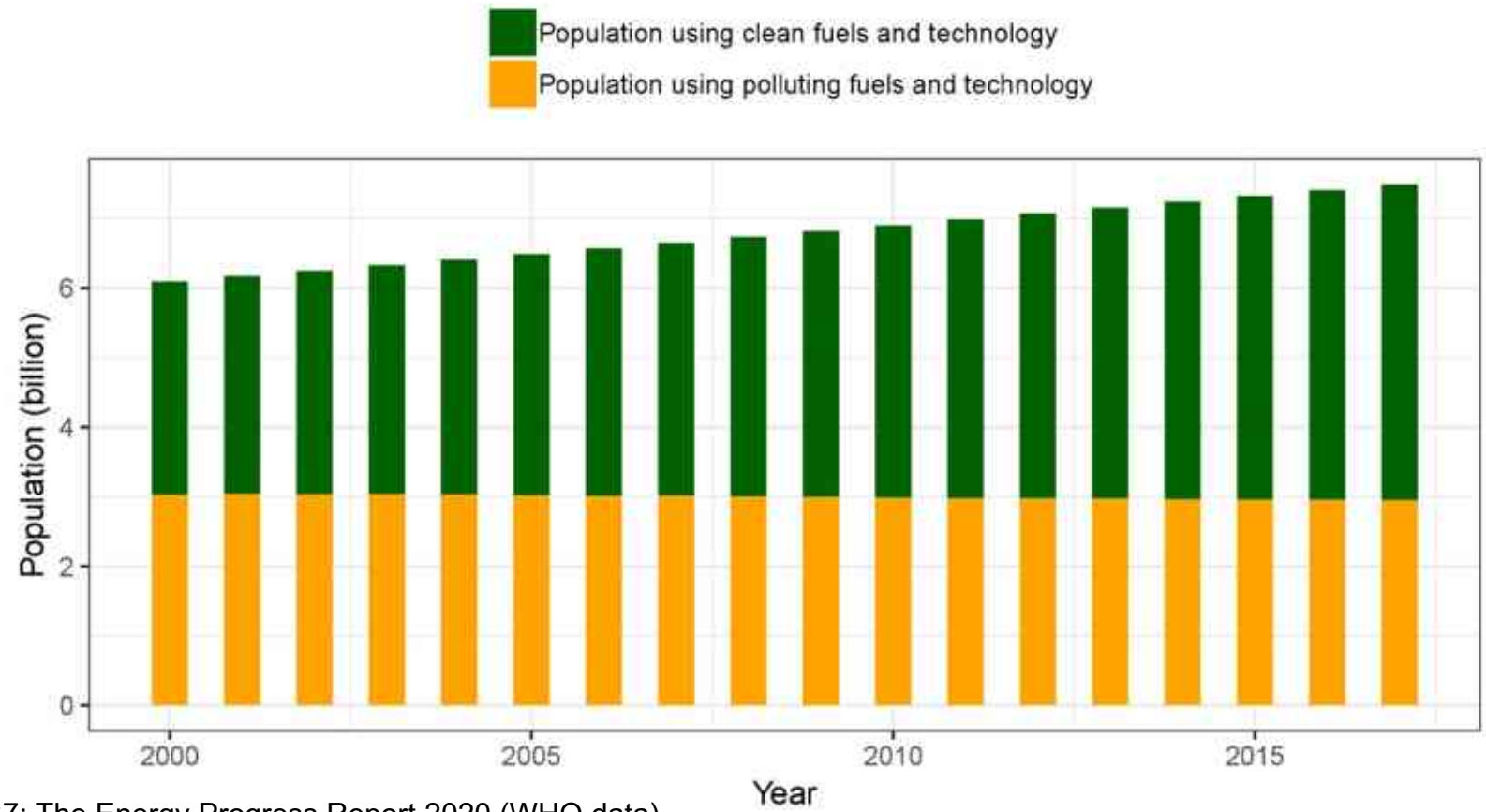
World Health Organization

- **Household air pollution (HAP)** is a mixture of pollutants released during incomplete combustion of carbon-based fuels (wood, coal, dung) in and around the home (not just indoors!)
- Released during use of inefficient **technologies** for activities including **cooking, heating, lighting**
- Particles <2.5μm in diameter penetrate into the lungs and affect the body contributing to diseases

Household air pollution: scope of problem

World Health Organization

- More than 3 billion people still cook with **polluting energy** sources
- Unchanged for 20 years

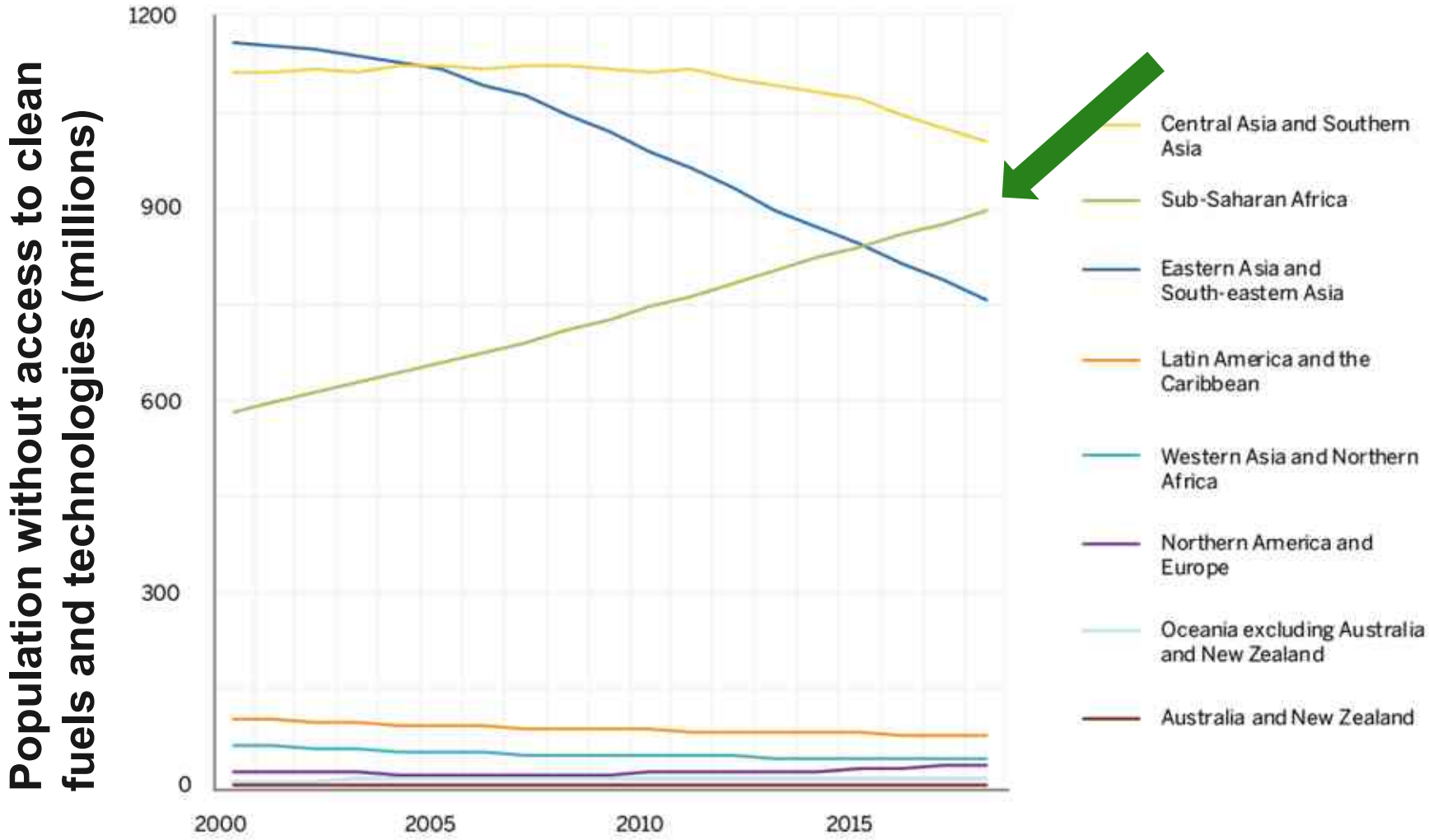


Tracking SDG7: The Energy Progress Report 2020 (WHO data)

Population primarily cooking with polluting fuels and technologies

World Health Organization

Increasing access deficit in Sub-Saharan Africa



Tracking SDG7: The Energy Progress Report 2020 (WHO data)

World Health Organization

Health impacts of household energy use

Health effects of HAP exposure: Particulate matter (PM)

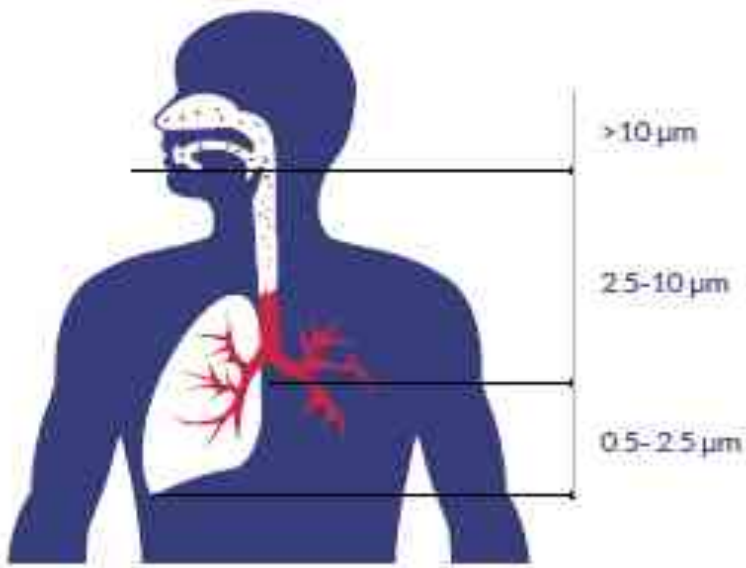
World Health Organization

Diseases Outcomes from HAP exposure with strong evidence:

- Ischaemic heart disease
- Stroke
- Chronic Obstructive Pulmonary Disease (COPD)
- Lung Cancer
- Pneumonia
- Cataract

Suggestive Evidence

- *Adverse pregnancy outcomes*
- *Cognitive Development*
- *Diabetes*
- *Tuberculosis*



Health effects of HAP exposure: Carbon Monoxide

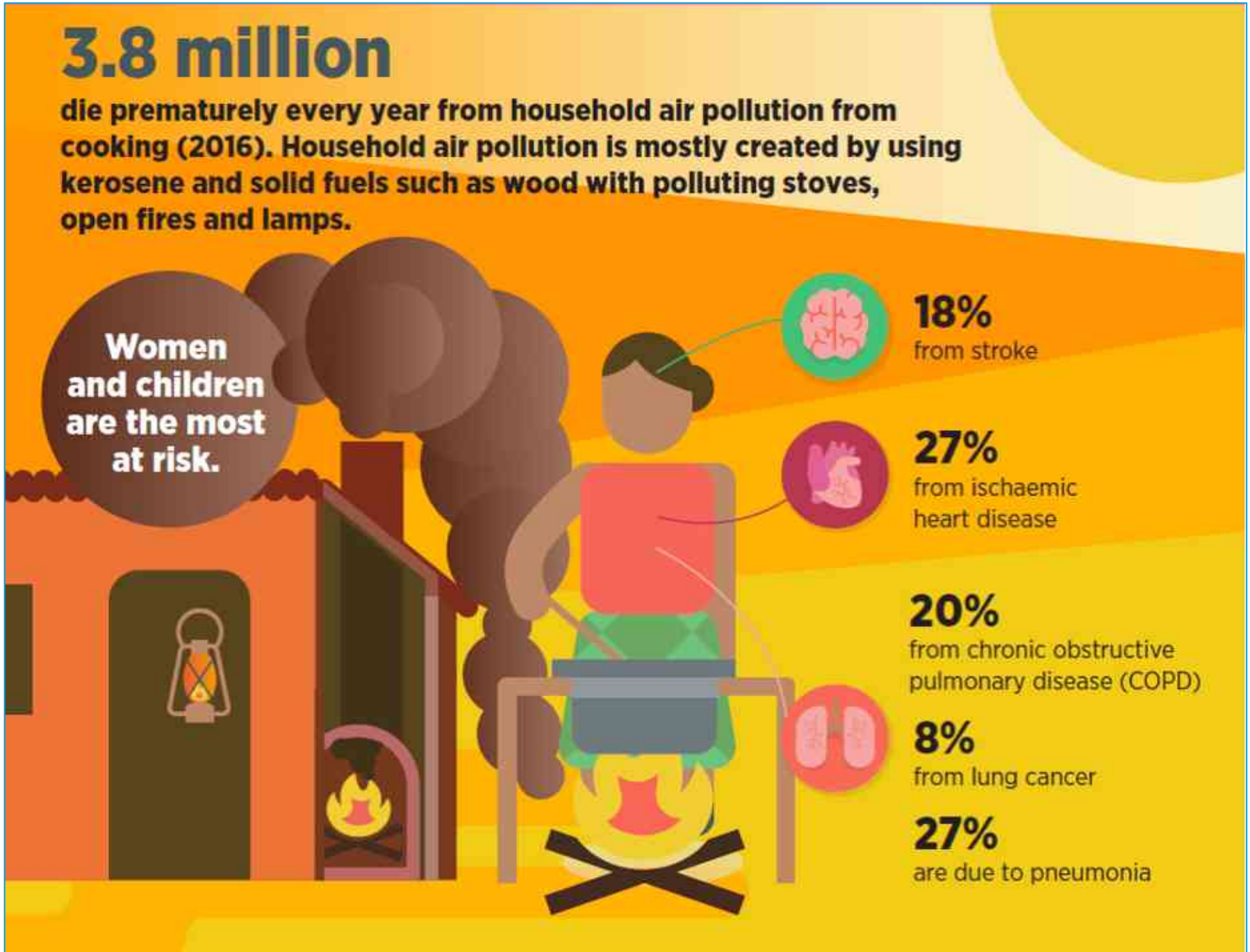
Carbon monoxide is released by inefficient stoves like charcoal stoves

Short-term (<24h) exposure to high levels of CO: acute toxicity and death

Long-term (>24h) exposure to low levels of CO increases the risk of chronic diseases including cardiovascular disease.
- Pregnant women: reduced birth weight

Household air pollution: Health toll

World Health Organization



Other health impacts of polluting household energy use

World Health Organization

Burns, scalds, poisonings & injury

Traditional stoves can pose major **safety** risks in the home.

Kerosene is a leading cause of childhood **poisonings** in low and middle income countries

Fuel collection can lead to **musculo-skeletal injuries** and is major source of time loss

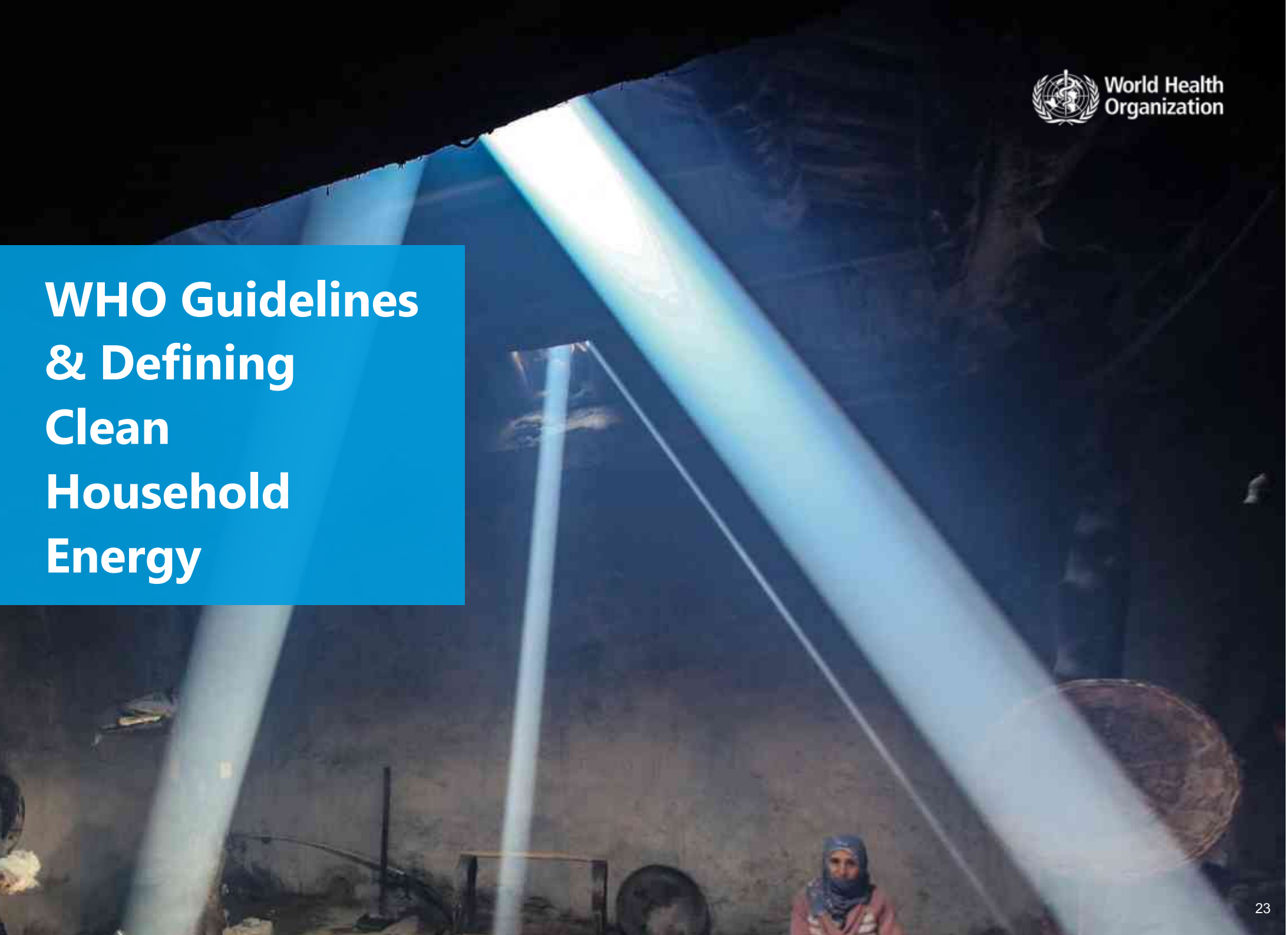
Environmental impacts of polluting household energy use

World Health Organization

Household air pollution is a major source of outdoor air pollution – **25–50%** in some countries (Chafe et al. 2014, Zhao et al. 2018)

Household cooking, heating and lighting produces **>50% of global anthropogenic black carbon** emissions (IIASA 2020)

Reliance on biomass leads to **deforestation**, decreased biodiversity (Bailis et al. 2015)



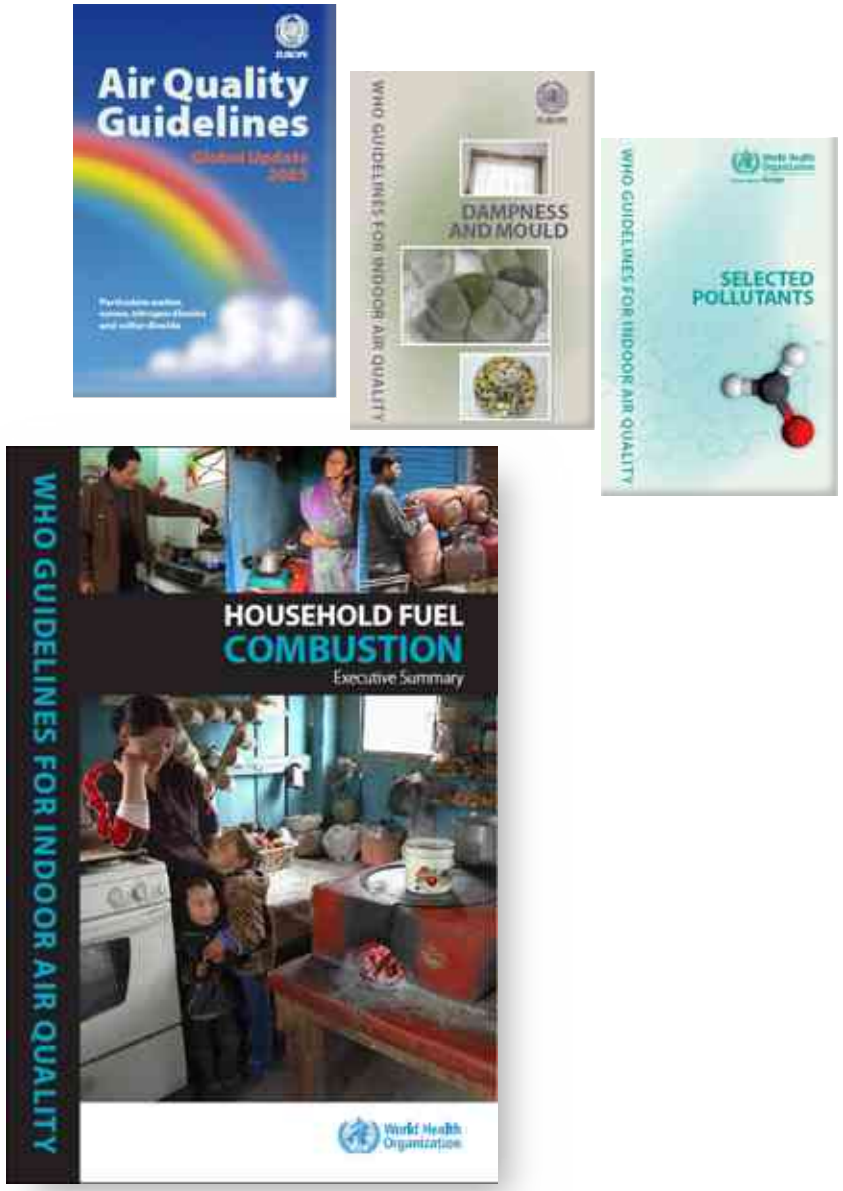
World Health Organization

WHO Guidelines & Defining Clean Household Energy

Existing (published) WHO Air Quality Guidelines (AQGs)

World Health Organization

- Global update (ambient) 2005:
  - $PM_{2.5}$, PM_{10}
  - Chapter on IAP
- Indoor AQG:
  - Dampness and Mould: 2009
  - Selected pollutants (CO): 2010
  - **<u>Household fuel combustion</u>**



WHO Air Quality Guidelines: $PM_{2.5}$ and carbon monoxide (CO)

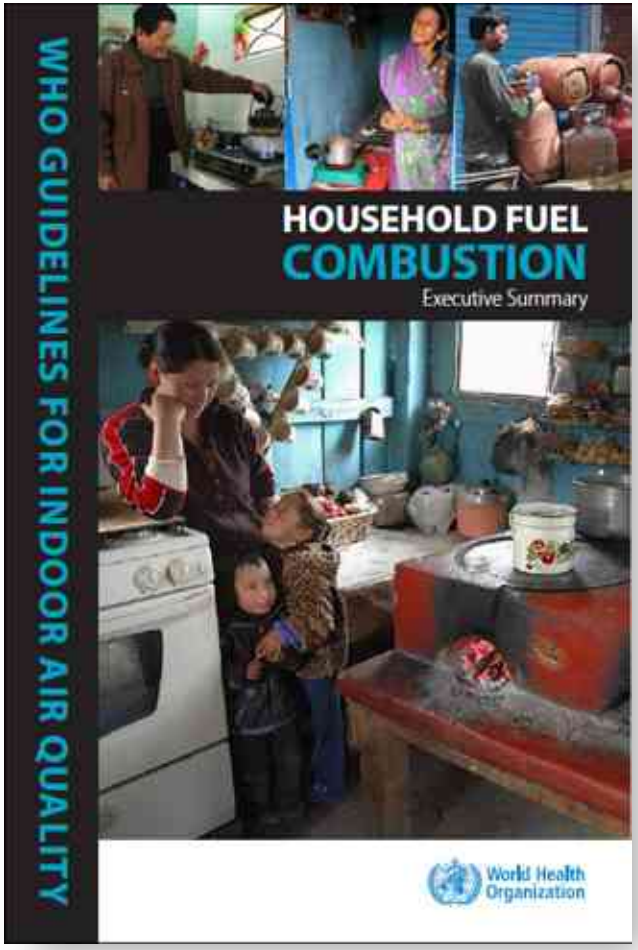
World Health Organization

Pollutant	Guideline or target	Exposure period	Level (µg/m³)
$PM_{2.5}$ (2005)	**Guideline**	**Annual average**	**10**
	IT-3		15
	IT-2		25
	IT-1		**35**
Pollutant	**Guideline or target**	**Exposure period**	**Level (mg/m³)**
Carbon monoxide (2010)	Guideline	8-hour	10
	Guideline	24-hour	**7**

WHO Guidelines for indoor air quality: household fuel combustion

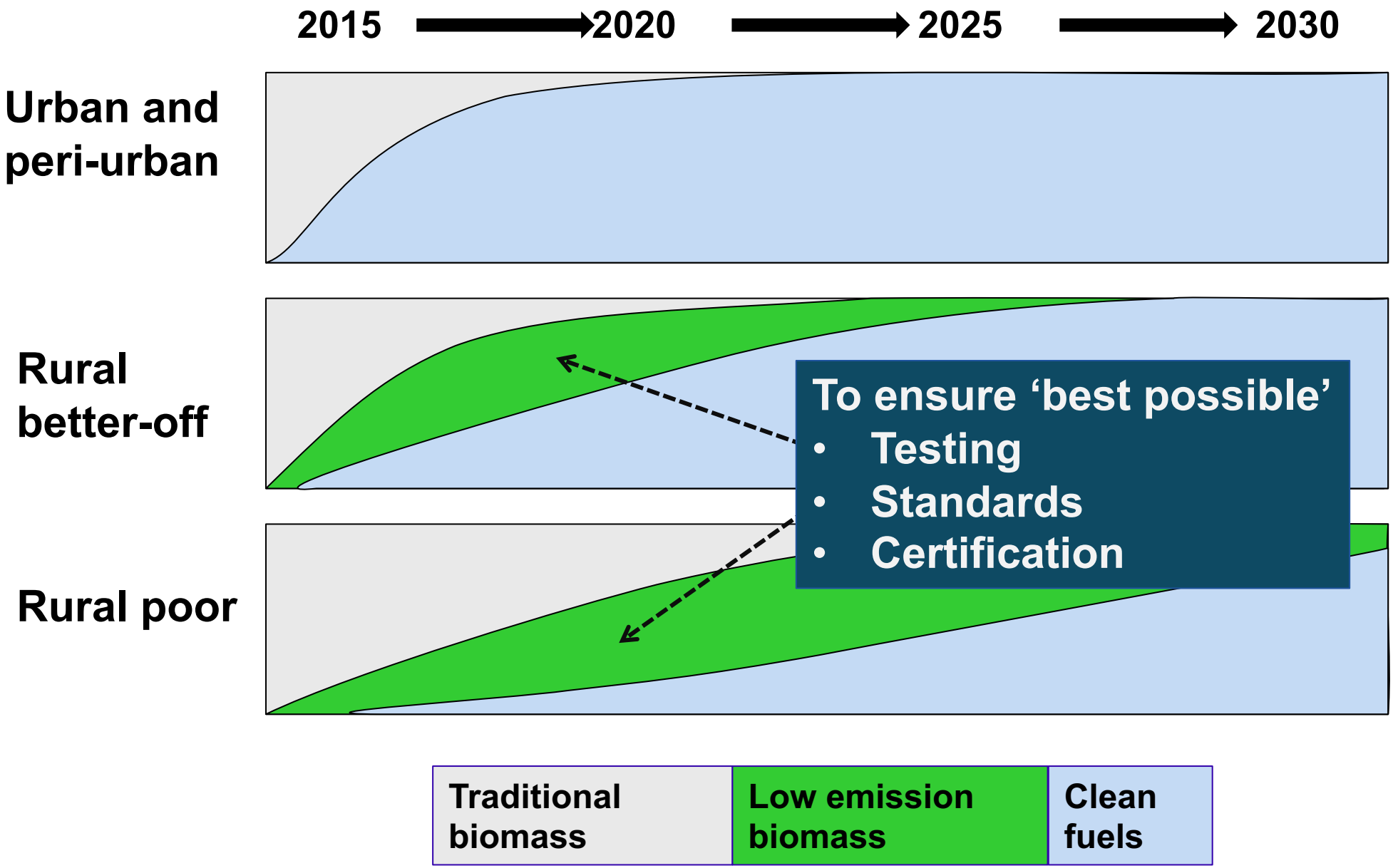
World Health Organization

Overview of Recommendations



- Provides **emission rate targets** for $PM_{2.5}$, and CO that determine whether fuel and technology combinations are “clean” for health
- **Policy in transition** calls for transitional fuels and technologies that are as clean as possible
- Specific fuels should be **avoided**: kerosene and unprocessed coal use
- Policies should **incorporate synergies** between climate, health and clean energy

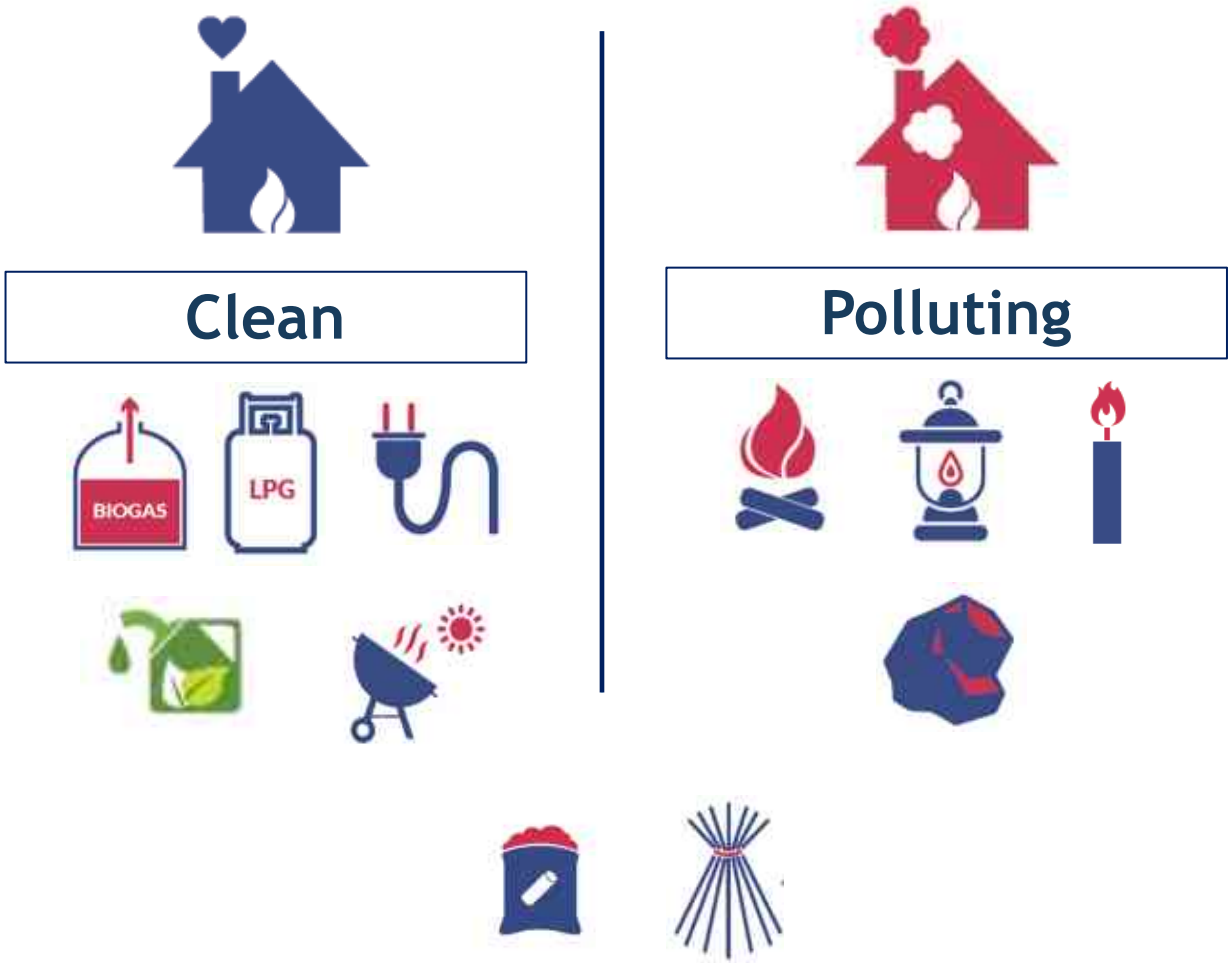
Recommendation 2: Policy during transition



Definition of "Clean" Household Energy for Health

World Health Organization

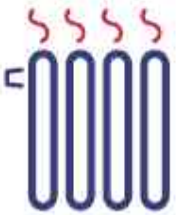
A MATTER OF FUELS AND TECHNOLOGIES



Biomass - does it achieve WHO Guidelines?
Linked to ISO Voluntary Performance Targets…

Reminder: Important to Consider Full Picture
All uses (cook, light, heat) must be clean

World Health Organization



World Health Organization

WHO Clean Household Energy Solutions Toolkit

Clean Household Energy Solutions Toolkit (CHEST) Overview

World Health Organization

+ *Step-by-step Guide*

Tools and resources for developing & implementing clean household energy policies & programmes

http://www.who.int/airpollution/household/chest/en/

Stakeholder Mapping & Needs Assessment

World Health Organization

Module Objectives:

- Identify key stakeholders working on household energy and health issues

- **Household Energy Assessment Rapid Tool (HEART) Templates** for mapping out current stakeholders and their roles related to household energy policies and programmes (*available online)*

- WHO Household Energy Database
  WHO Household Air Pollution Measurement Database

http://www.who.int/airpollution/household/interventions/chest-module1/en/
https://www.who.int/airpollution/household/interventions/chest-module2/en/

Identification of Technological and Policy Interventions

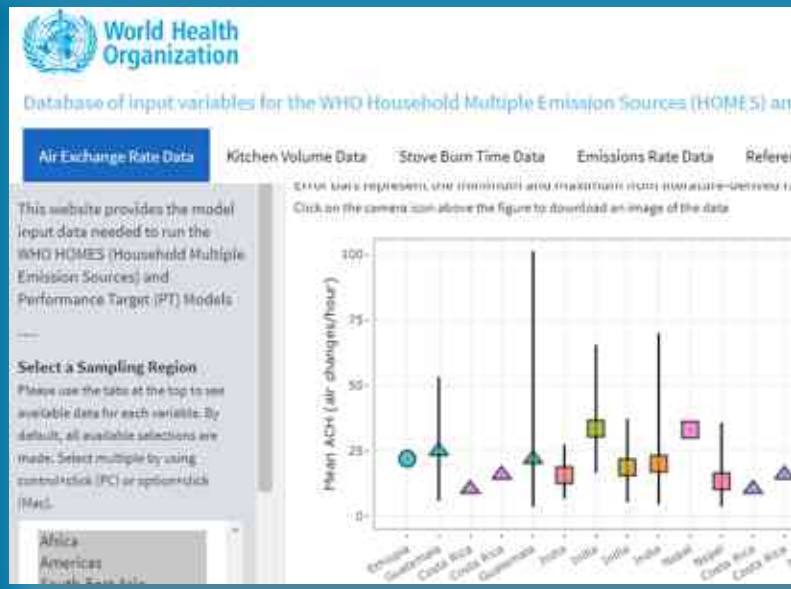
Identify policy and technological solutions

World Health Organization

Module Objectives:

- Evaluate health risk from different technological interventions through an **interactive web-based emissions model, protocols** for measuring input data, and a **database** of input values (*available online*)
- Assess costs and benefits of cleaner cooking transition with **BAR-HAP** tool *(available online)*
- Provide clearinghouse of examples of national household energy policies in **policy database** *(under development)*

https://www.who.int/airpollution/household/interventions/chest-module3/en/

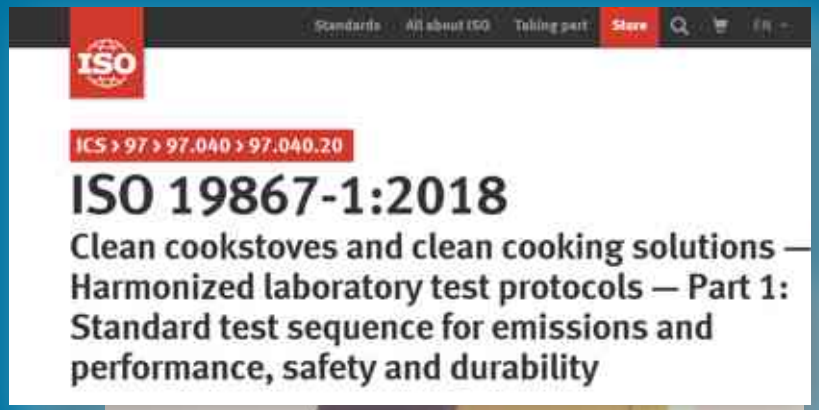


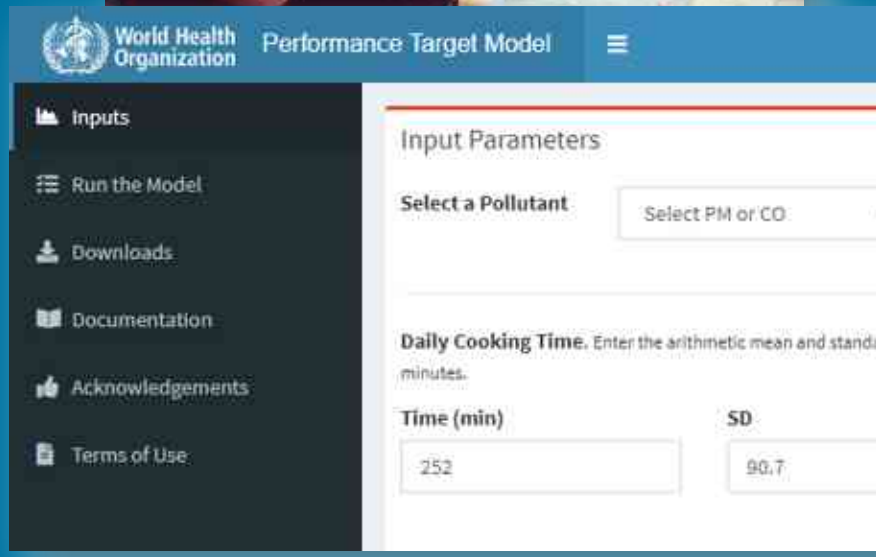
Guidance on Standards & Testing

World Health Organization

Module Objectives:

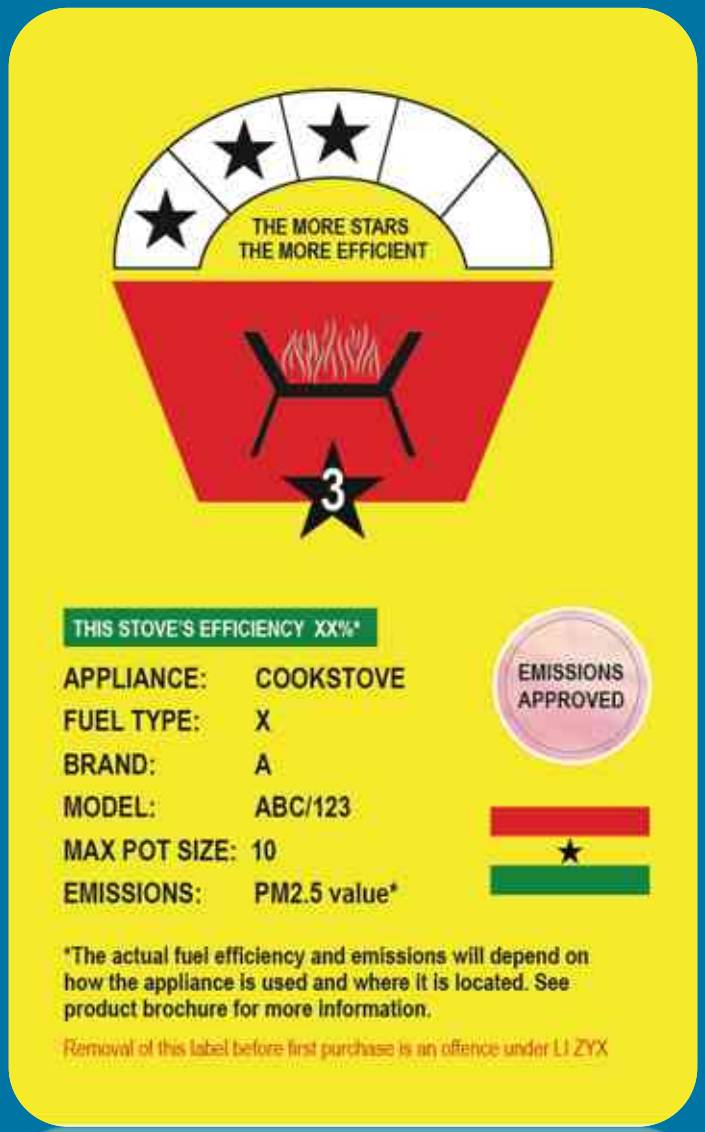
- **Support adoption/adaptation of national standards** for cookstoves, such as those produced by International Organization for Standardization (ISO)
  - WHO Setting National Cookstove Targets document in peer review
  - Two regional workshops on cookstove standards completed (Nepal 2018 and Uganda 2019), currently conducting virtual Francophone series (USEPA, CCA, ISO)
    - Next standards workshop: ***Senegal***
- **Build capacity** for the development adaptation of national standards with a web-based model for setting national performance tiers *(available online)*





https://www.who.int/airpollution/household/interventions/chest-module4/en/

Standards and testing: Sample Label for National Standards



Courtesy: Clean Cooking Alliance

Standards for labelling can include information on:

- Energy efficiency (star rating)

- Emissions level to protect health (“emissions approved”)

Monitoring & Evaluation

World Health Organization

Module Objectives:

- Provide the tools and resources necessary to effectively monitor and track household energy use and impacts
  - Core questions on household energy use finalized (adopted by MICS, DHS) (*available online)*
  - Guidebook for adoption in national censuses nearly finalized (WHO/WB)

https://www.who.int/airpollution/household/interventions/chest-module5/en/

Engaging the Health Community & Communications

World Health Organization

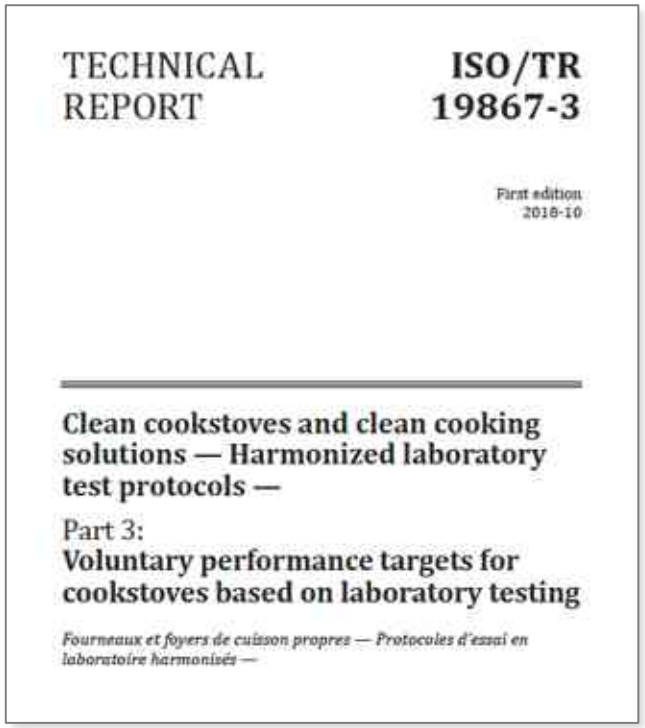
Module Objectives:

- Educate and raise awareness of health professionals about health risks from household energy use
- Provide health professionals with the tools to assess household energy as a risk factor for disease and 'prescribe' clean household energy
  - Training materials under development for clinicians
  - Breathe Life Campagn underway

World Health Organization

Setting Voluntary Performance Targets

ISO Voluntary Performance Targets



TECHNICAL REPORT

ISO/TR 19867-3

First edition
2018-10

Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols —

Part 3:
Voluntary performance targets for cookstoves based on laboratory testing

Fourneaux et foyers de cuisson propres — Protocoles d'essai en laboratoire harmonisés —

- Technical Report - Part three of ISO harmonized laboratory test protocols standard
- Developed by ISO Working Group with international majority consensus
- Performance metrics are linked to ISO test protocols
  - Thermal efficiency
  - Emissions
  - Safety
  - Durability
- Tier system has performance ranging from simple/traditional stoves (Tier 0) to aspirational targets (Tier 5)

https://www.iso.org/standard/73935.html?browse=tc

Berkeley Air Monitoring Group

World Health Organization

Overview of Tiers of Performance

	Tier[b]	Thermal efficiency %	Emissions		Safety (score)[c]	Durability (score)[d]
			CO g/MJ$_d$	$PM_{2,5}$ mg/MJ$_d$		
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

Berkeley Air Monitoring Group

World Health Organization

Why do we need performance targets?

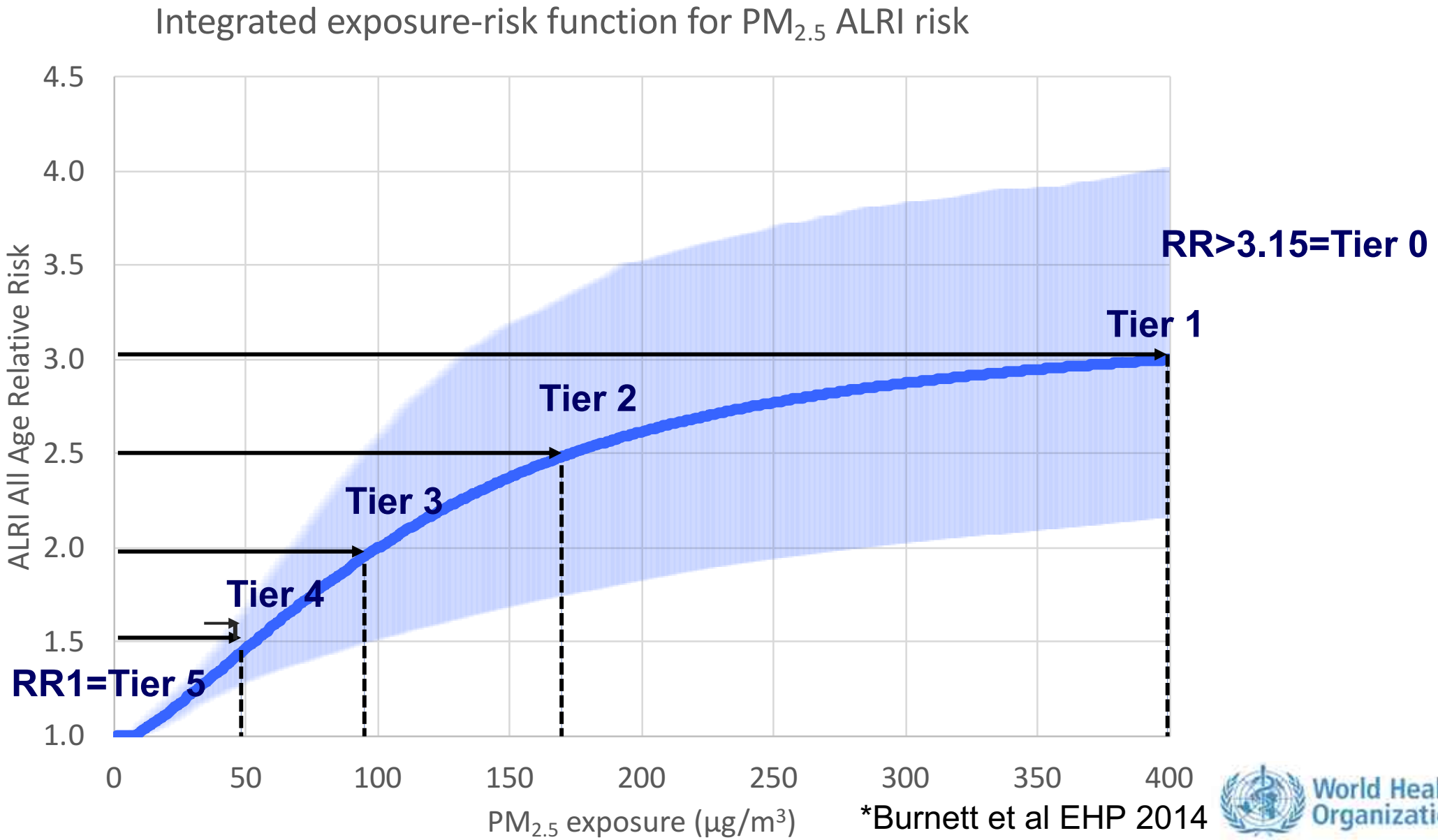
- ISO Voluntary Performance Targets are **voluntary**
- Emissions targets (PM, CO) are aligned with **WHO Guidelines**
- Countries can use VPTs to set local standards of acceptability
- Tiers can be used in labelling to provide information to consumers
- Complimented with tools to help adapt targets for specific locations and/or contexts

Berkeley Air Monitoring Group

World Health Organization

ISO PM2.5 Targets

The relationship with **acute lower respiratory infections** was used to determine the targets



*Burnett et al EHP 2014

World Health Organization

ISO Carbon Monoxide (CO) Targets

- Developed with same model and inputs as used as for PM2.5
- No exposure response established between CO concentrations and risk
- Targets determined by looking at different percentages of homes meeting the WHO 24 hour CO guideline (7mg/m^3) (WHO 2010)

	Tier	Emission factor g/MJ$_d$ delivered	Percent of homes covered at 7 mg/m^3 daily average[a]
Better performance	5	≤3,0	≥90 %
	4	≤4,4	≥80 %
	3	≤7,2	≥60 %
	2	≤11,5	≥40 %
	1	≤18,3	≥20 %
	0	>18,3	<20 %

Berkeley Air Monitoring Group

World Health Organization

Additional Notes

- ✓ Region-specific targets can be developed
- ✓ Tier ratings should be reported separately
  (e.g., Tier 3 for PM2.5,
  Tier 5 for CO- there is no such thing as a "Tier 3 stove")
- ✓ The performance targets may be updated within the ISO system as more data becomes available
- ✓ Performance targets are one useful tool in an ecosystem of design, production, sales, user training, customer awareness, etc…
- ✓ A high-performing stove that does not get sold or displace polluting fuels and technologies will not have impact

Berkeley Air Monitoring Group

World Health Organization

Thank you

Jessica Lewis
WHO Air Quality and Health Unit

Householdenergy@who.int

Modeling tools for voluntary performance targets

Michael Johnson

November, 2020

Berkeley Air Monitoring Group

Always a group effort, thank you to…

WHO and ISO

Ajay Pillarisetti,
Emory University

Ricardo Piedrahita,
Berkeley Air

Outline

Linking indoor air quality with emissions performance

WHO Performance Target Model

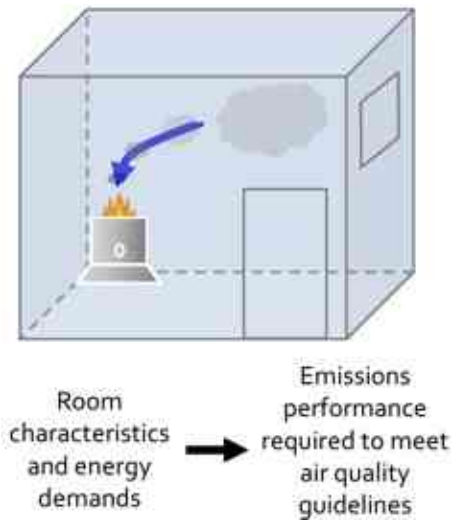
WHO HOMES Model

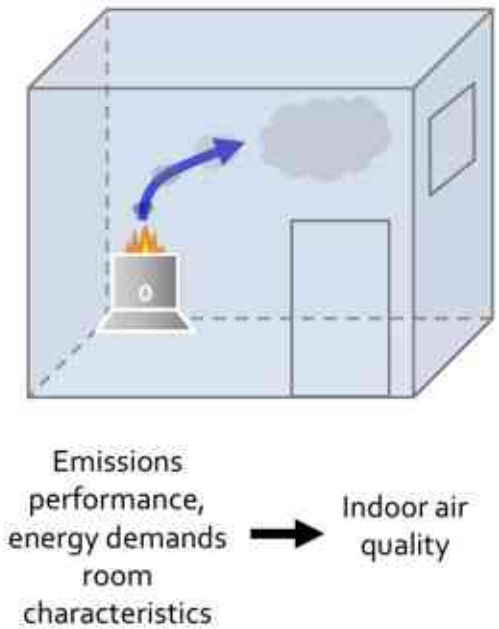
Support materials

- Background information
- Support Materials
- Databases

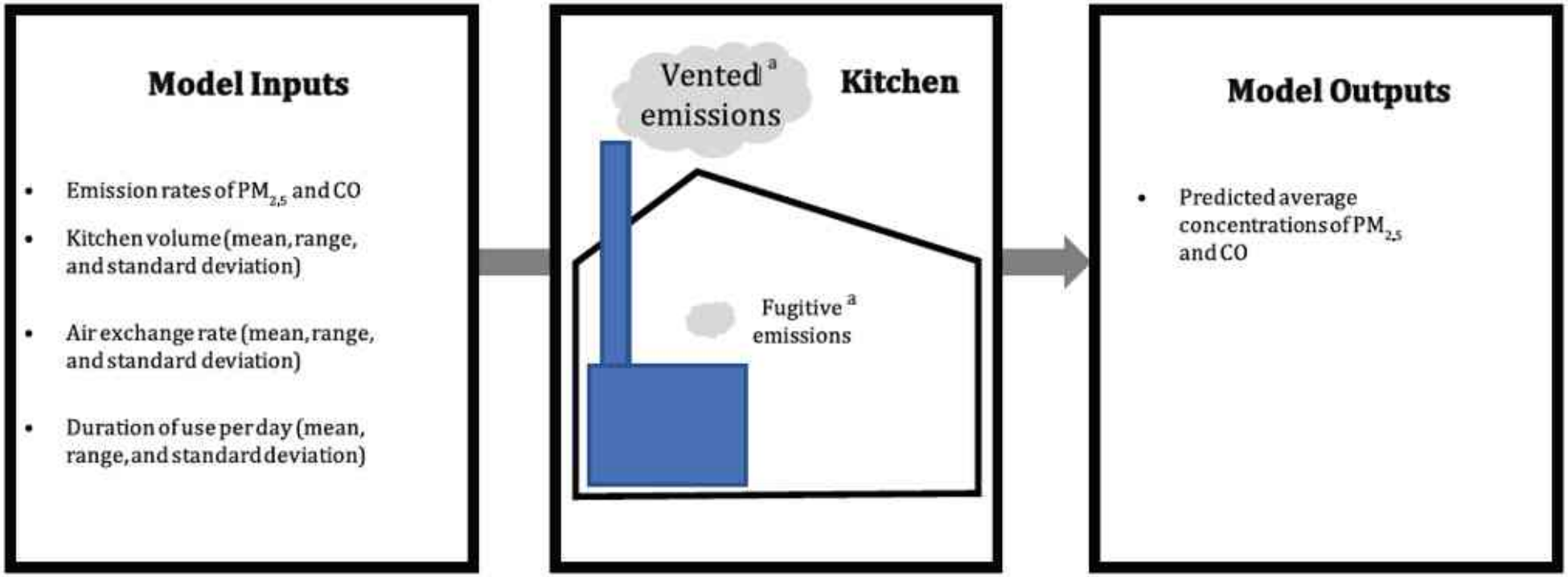
Purpose of the two models

Model	Purpose	Inputs	Outputs
Performance Target model (WHO-PT)	- Backwards looking: Estimate emissions performance to meet an air pollutant concentration or health target. - Derives emissions performance targets.	Kitchen volumes, ventilation rates, and cooking times	Emissions performance targets
Household multiple emissions source model (WHO-HOMES)	- Forward looking: What concentrations, exposures, and additional risk result from emissions sources in the home? - Tool for exploring implications of various stove performance/ usage scenarios.	Kitchen volumes, ventilation rates, emission rates (multiple sources), usage times (multiple sources, background concentrations, and exposure factors	Kitchen and personal exposure concentrations, health risk





How do we link emissions with air quality or health targets?



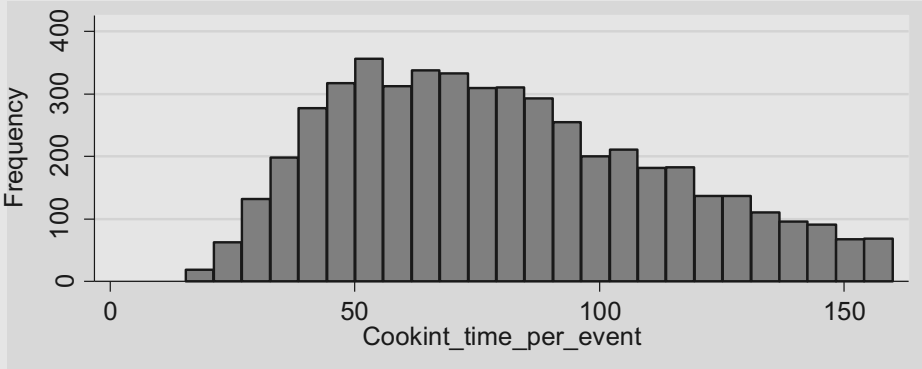
$$C_t = \frac{Gf}{\alpha V}\left(1 - e^{-\alpha t}\right) + C_o\left(e^{-\alpha t}\right)$$

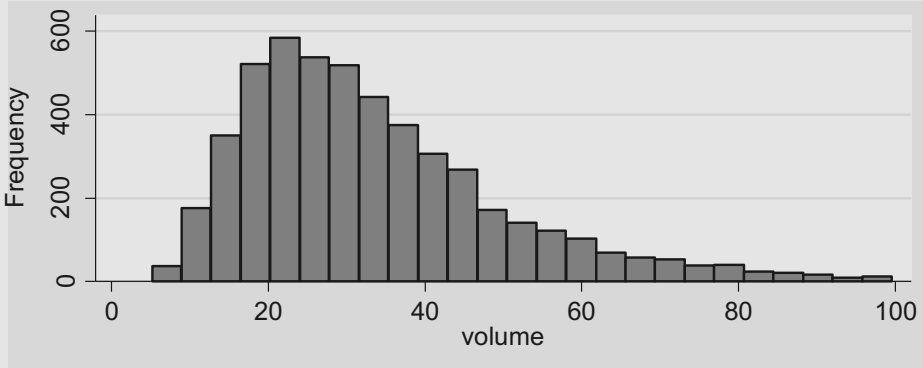
C_t = Concentration of pollutant at time t (mg m^{-3})
G = emission rate (mg min^{-1})
α = first order loss rate (nominal air exchange rate) (min^{-1})
V = kitchen volume (m^3)
t = time (min)
C_o = concentration from preceding time unit (mg m^{-3})
f = fraction of emissions that enters the kitchen

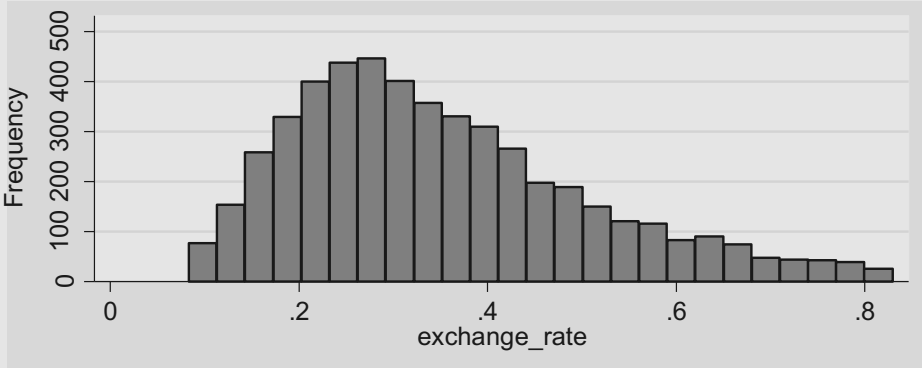
Single zone model is a very common and simple air quality model

Used for many applications, including for the WHO Air Quality Guidelines: Household fuel combustion (2014)

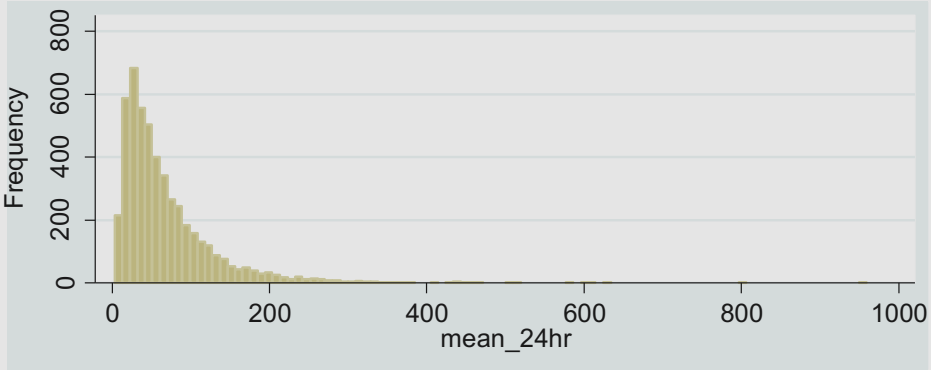
Run the model with data that reflect the distributions of cooking time, kitchen volumes, and exchange rates







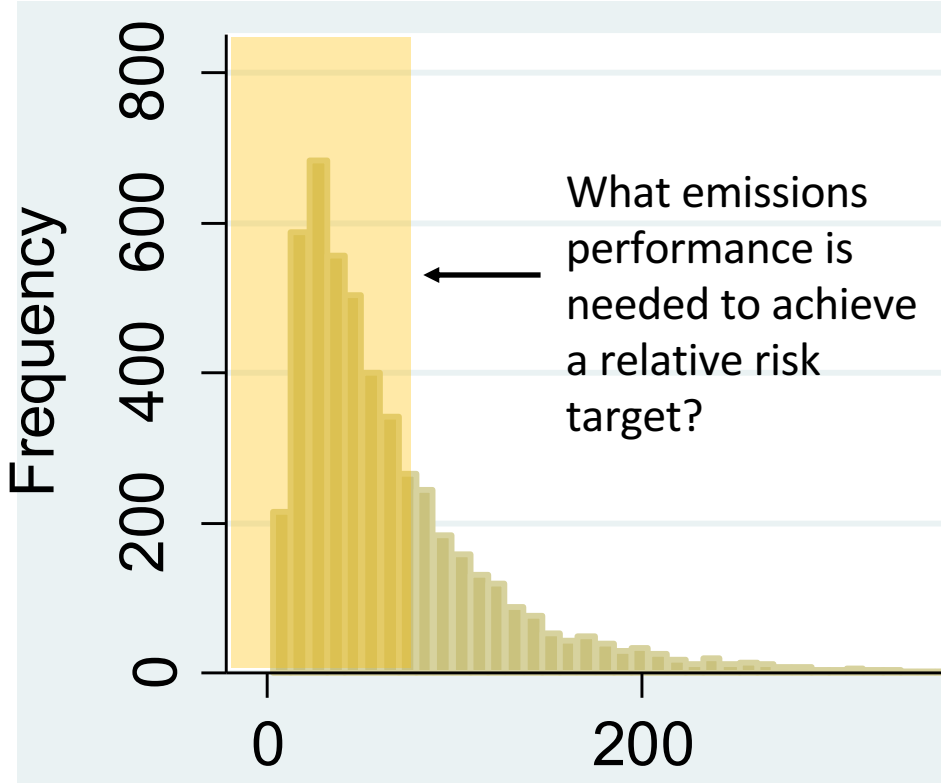
Get out a distribution of predicted 24 hour pollutant concentrations

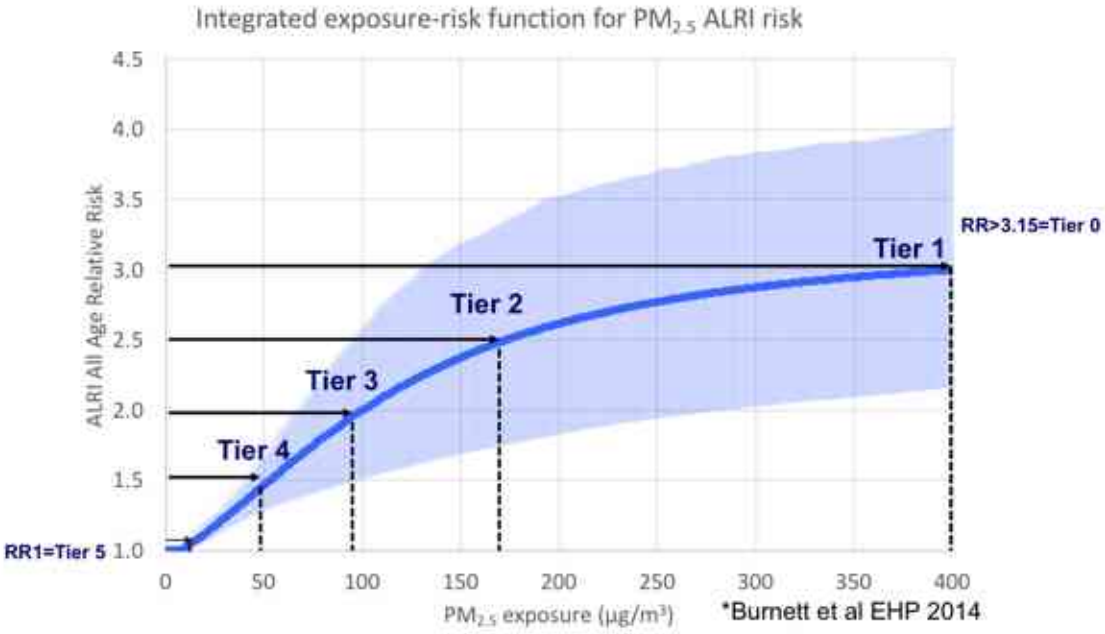


World Health Organization

Berkeley Air Monitoring Group

Setting performance targets using air quality goals





	Tier	RR	mg/MJ$_d$	Normalized Emission Rate mg/min	μg/m³	Percentage of homes meeting the tier level
Better performance	5	1,0	≤5	≤0,2	≤10	≥90 %
	4	≤1,5	≤62	≤2,7	≤50	≥50 %
	3	≤2,5	≤218	≤9,5	≤170	≥50 %
	2	≤3,0	≤481	≤21	≤400	≥50 %
	1	≤3,15	≤1 031	≤45	≤800	≥50 %
	0	>3,15	>1 031	>45	>800	<50 %

NOTE Tier reporting is based on emission factor, and normalized emission rate is a derived property. Measured emission rates from laboratory testing are not used to determine tiers for reporting.

World Health Organization

Berkeley Air Monitoring Group

Targets are based on global averages for the model inputs

Table 8 — Model input assumptions for default emission factor targets for $PM_{2,5}$ and CO

Model input variable	Values utilized				Source data (references in Bibliography)
	Mean	Range		Standard deviation	
		Minimum	Maximum		
Air exchange rate (ACH)	21[a]	4	100	11	[11][13][14] [18][23][24] [27]
Kitchen volume (m^3)	28[a]	5	100	16,8	[9][10][12][16][17][19][20][21] [22]
Duration of cooking (h/day)	4,2[b]	1	8	1,5	[9][10][13] [15][16][17][28]

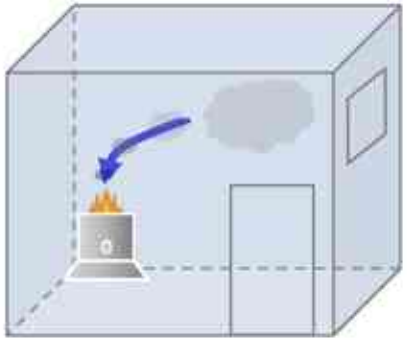
[a] Geometric mean.

[b] Arithmetic mean.

Also high and low ventilation rate default scenarios

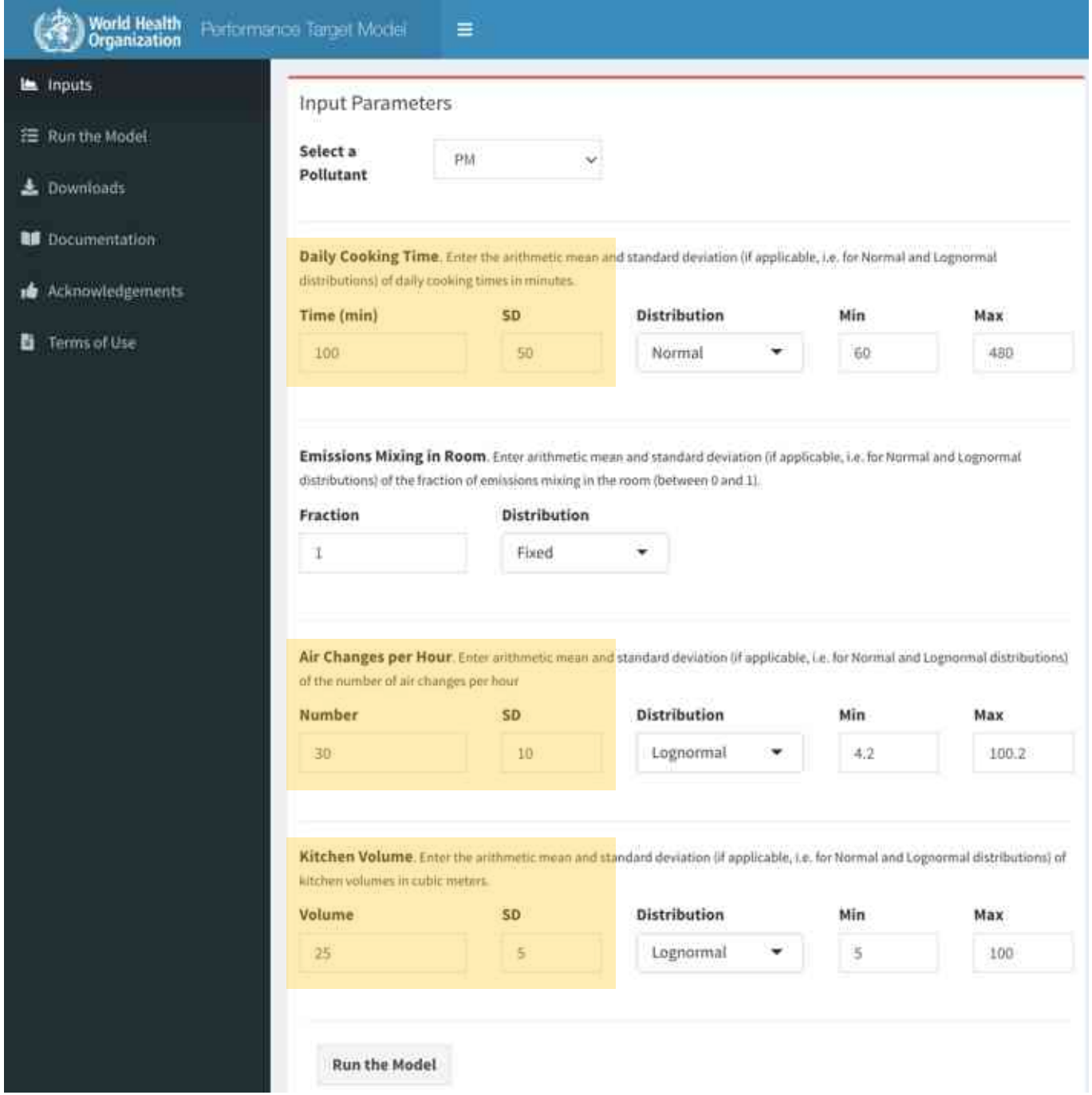
WHO Performance Target Model

emissions targets <- concentrations



WHO Performance Target Model Input

Location specific inputs for cooking time, ventilation, and kitchen volume



https://worldhealthorg.shinyapps.io/who_pt/

World Health Organization Performance Target Model

- Inputs
- Run the Model
- Downloads
- Documentation
- Acknowledgements
- Terms of Use

Households Meeting Targets

Tier	Emission Rate (mg/min)	Coverage	Emission Factor (mg/MJd)	Pollutant
User Input (10 µg/m3)	1.5	50%	13.6	PM
Tier 5 - RR 1 (10 µg/m3)	0.83	90%	7.5	PM
Tier 4 - RR 1.5 (50 µg/m3)	7.9	50%	71.8	PM
Tier 3 - RR 2.5 (170 µg/m3)	27.1	50%	246.4	PM
Tier 2 - RR 3 (400 µg/m3)	63.9	50%	580.9	PM
Tier 1 - RR 3.15 (800 µg/m3)	100	50%	909.1	PM

Showing 1 to 6 of 6 entries

Coverage is the percent of modelled homes meeting the tier level. Please note that emission targets will vary slightly if you run the model multiple times, even when using the same input parameters. This variation occurs because the inputs for each of the thousands of simulations are randomly drawn from distributions based on your inputs. It is recommended that targets from the first model run from any given set of input distributions be used.

Levels of Protection

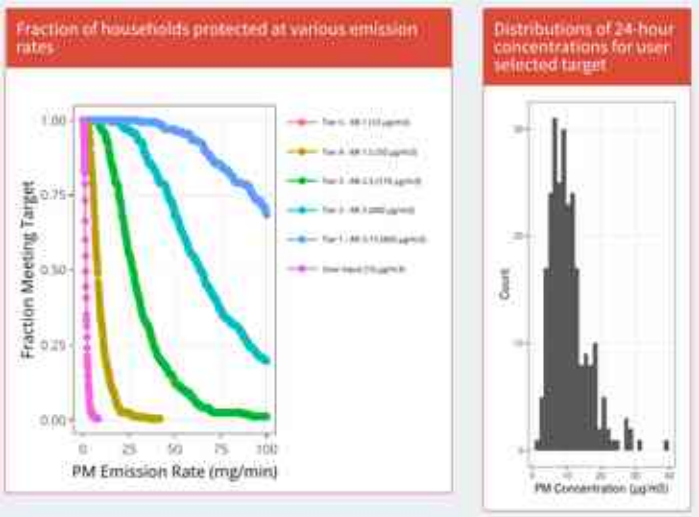
Level of Protection. Users may enter a concentration target in µg/m³. For example, these can be from local or national air quality guidelines. The summary table above and the graph below will change to reflect any user input concentration. As long as input concentrations are the same, it is not necessary to re-run the model, and multiple different concentration targets can be entered.

Tier 5 - RR 1 (10 µg/m3)

Summary. To protect 50% of households at a 24 hour average PM concentration of 10 µg/m³, the maximum emission rate should be 1.5 mg/min or lower.

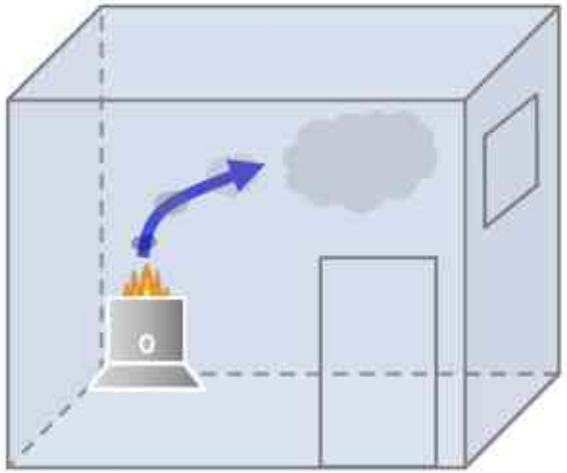
WHO Performance Target Model Output

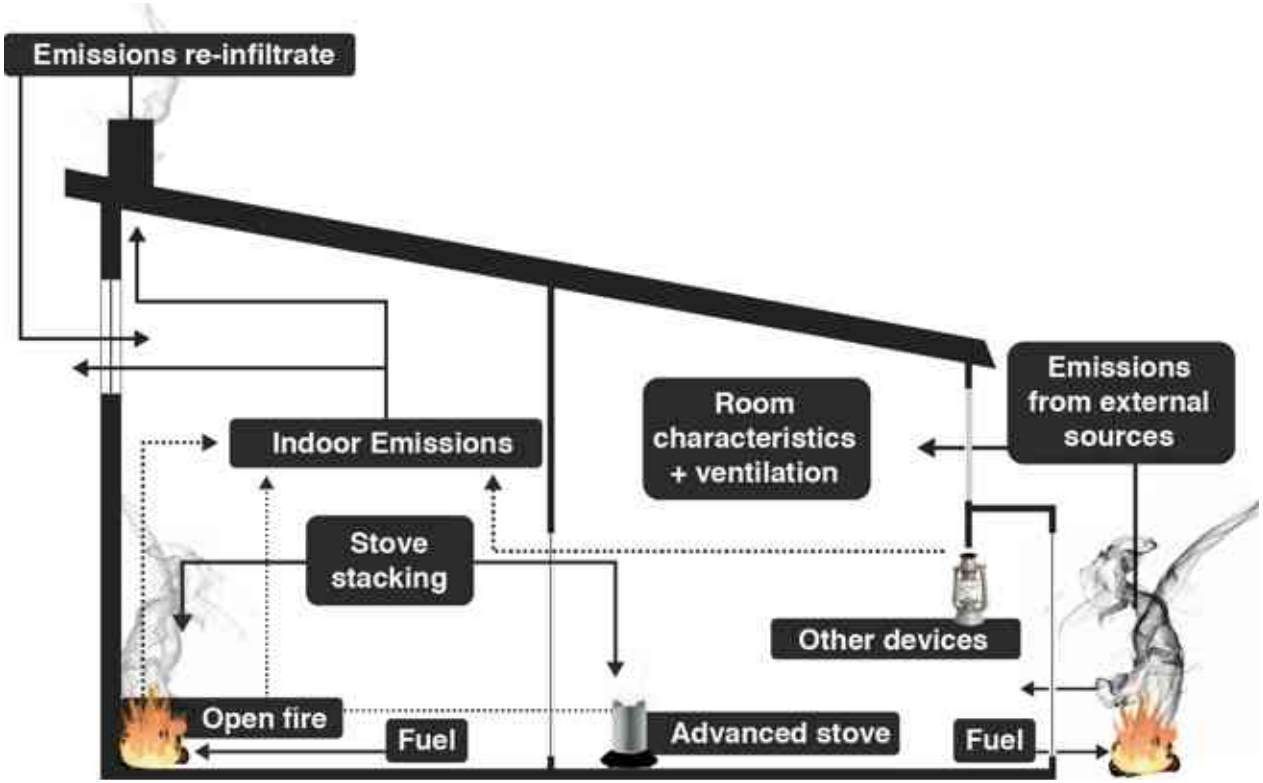
Location specific performance targets



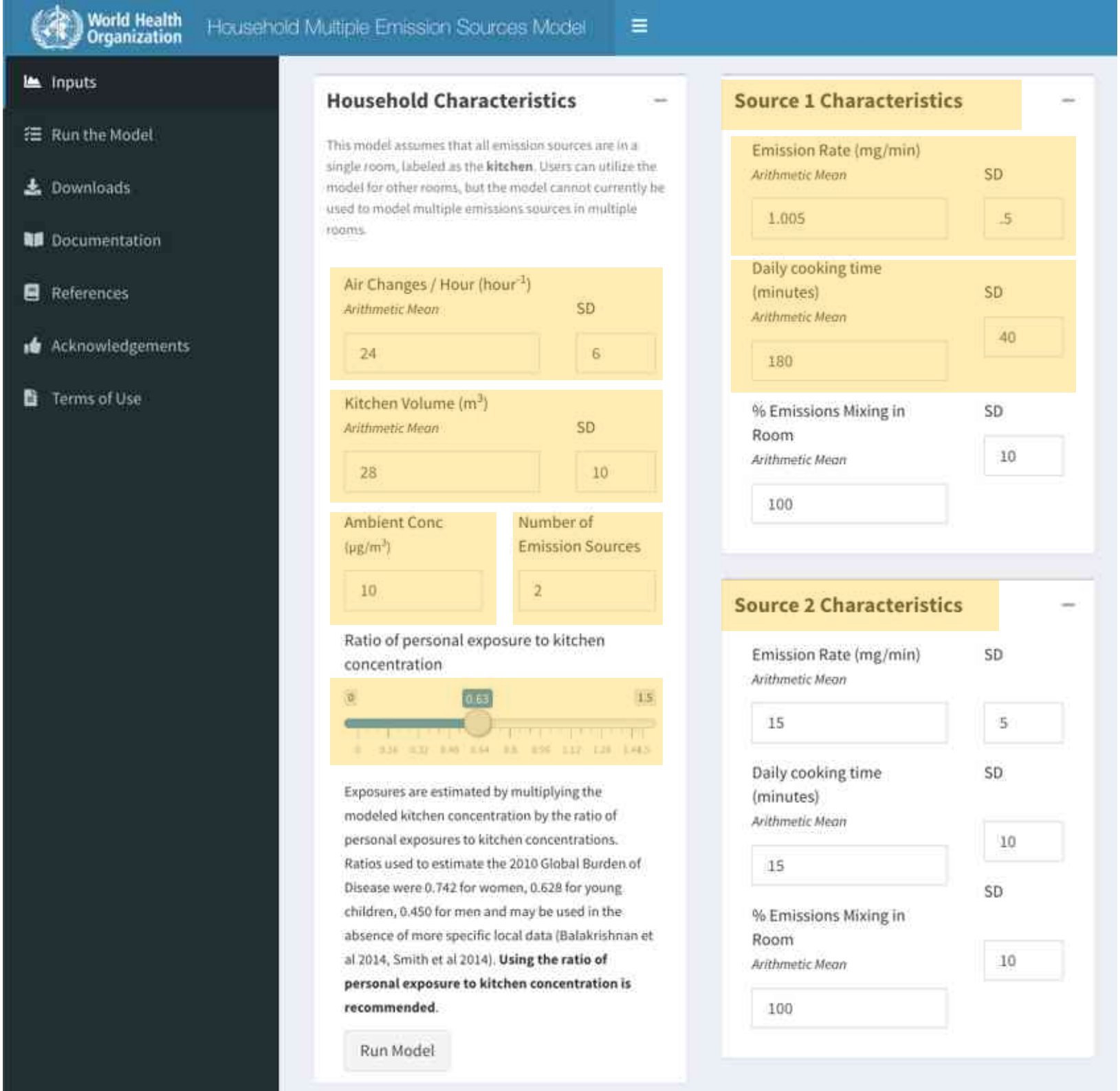
WHO Household Multiple Emissions Sources Model

sources -> concentrations/exposures





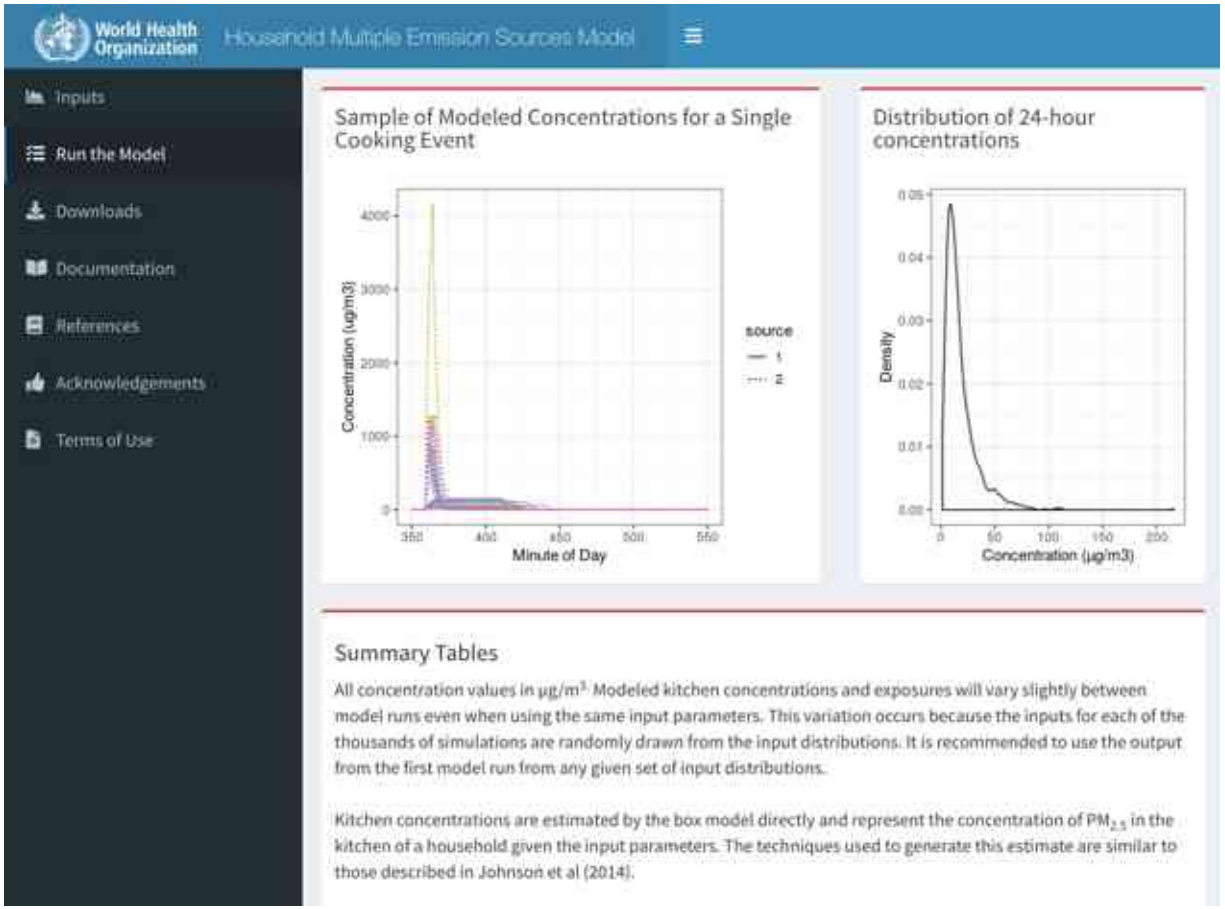
Credit: Ajay Pillarisetti



WHO HOMES Input

Location specific inputs for cooking time, ventilation, emissions source characteristics, ambient concentrations, and exposure factors

https://worldhealthorg.shinyapps.io/who_homes/



Mean Concentration	24 hour average	SD Concentration	Max Concentration
17.939	Kitchen Concentration	15.838	215.842

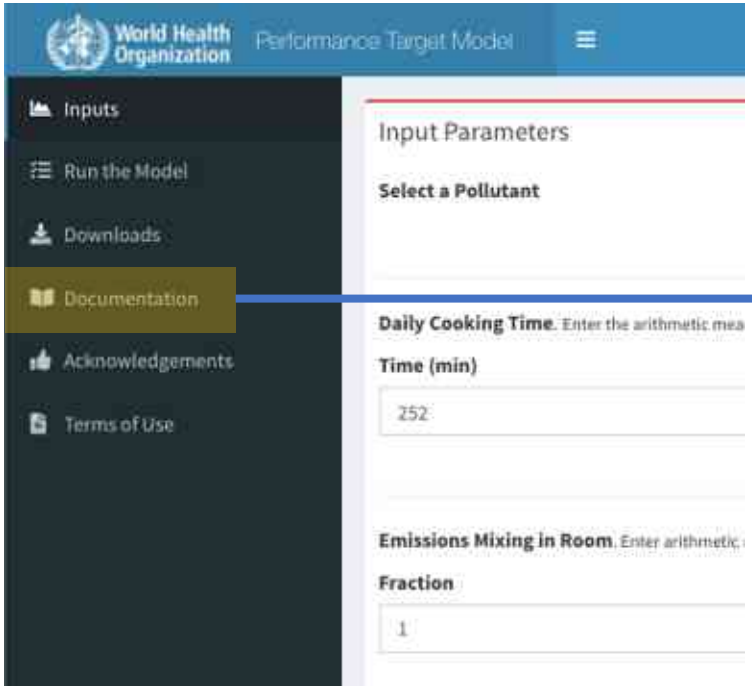
Exposures are estimated by multiplying the modeled kitchen concentration by the ratio of personal ex
kitchen concentrations (**This is the recommended method**). Ratios used to estimate the 2010 Global E
Disease were 0.742 for women, 0.628 for young children, 0.450 for men and may be used in the absence
specific local data (Balakrishnan et al 2014, Smith et al 2014).

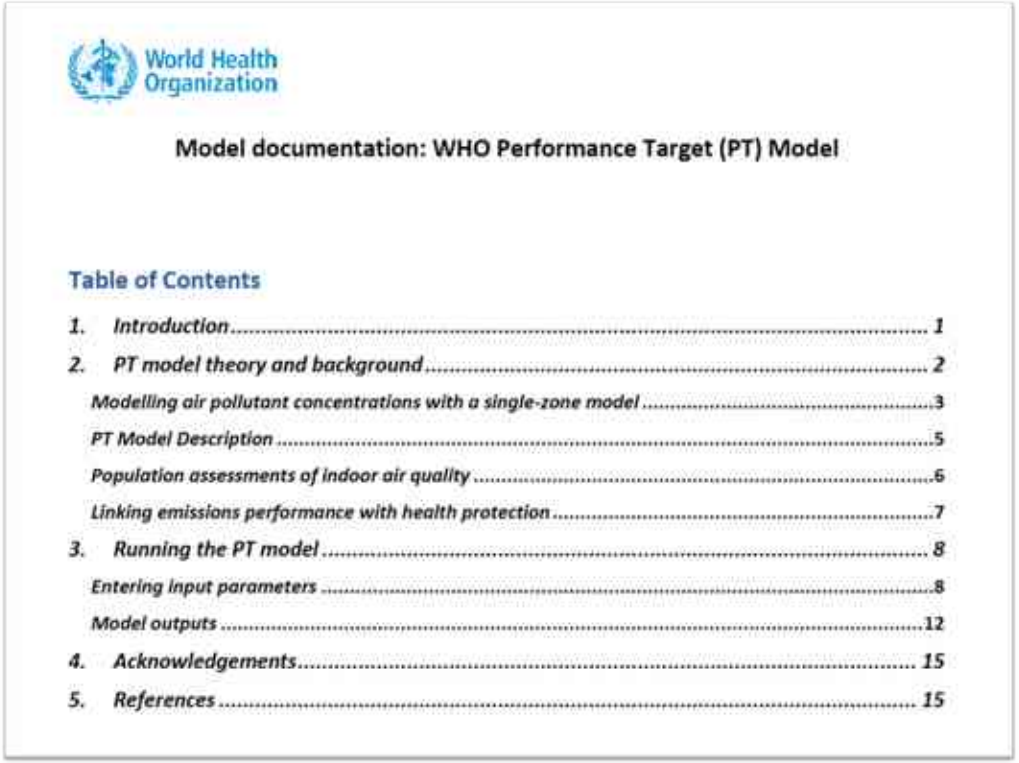
Mean Concentration	24 hour average	SD Concentration	Max Concentration
11.302	Exposure	9.978	135.98

WHO HOMES Output

Kitchen and personal exposure estimates for the given stove performance/use scenario

Support materials: Background information





World Health Organization

Model documentation: WHO Performance Target (PT) Model

Table of Contents

Support materials: Protocols

https://www.who.int/airpollution/household/interventions/chest-module3-inputdata/en/

Input data to run Household Multiple Emission Sources (HOMES) and Performance Target (PT) models

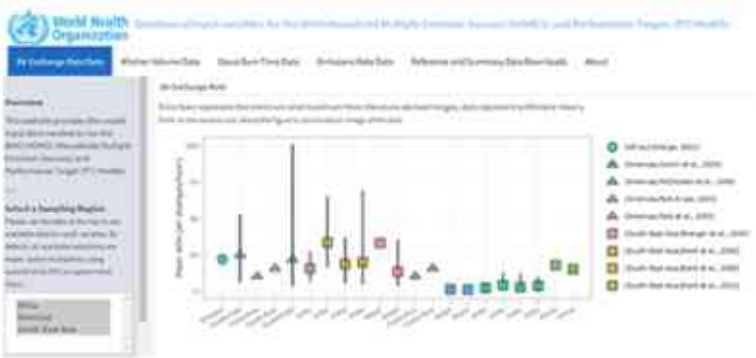
Protocols

WHO developed a set of protocols for measuring key input data that are needed to run the HOMES and PT models. Each protocol provides step-by-step guidance for collecting the necessary data in field conditions.

These protocols include:

- Air change rate
  pdf, 775kb
- Kitchen volume
  pdf, 821kb
- Device use time / cooking time
  pdf, 1.77Mb
- Other parameters
  pdf, 685kb
  (fraction of emissions entering room, which is important for chimney stoves; background pollution concentration; exposure factors; emission rates)

Database of input data



In addition to the protocols, WHO has developed a database (access here) of the input values needed to run the HOMES and PT models. This database is a valuable resource for countries and implementers who may not have the resources or time to collect the input data for the models. The database contains data from research studies on:

- Air exchange rate
- Kitchen volume
- Device use time / cooking time
- Emissions rate ($PM_{2.5}$ and CO)

Model Parameter: Room (kitchen) volume

Objective

Measure and calculate the room volume where the emissions source(s) is/are present, generally the kitchen.

Background and context

Kitchen volume is generally straightforward to measure and can be assessed relatively rapidly with simple equipment. For the purposes of the WHO Household Multiple Emission Sources (HOMES) and Performance Target (PT) Models, the **kitchen** is defined as an indoor room with four walls and a ceiling. Thus, this protocol can also be used to calculate the volume of a different room if that is where the emission source is used (e.g., living room or secondary kitchen in the case of measuring emissions from a device like a combined cooking-heating stove). The volume should include the entire space that is not separated by a barrier such as a door or wall, even if that includes a living or sleeping area. In cases where this separation is not clear, a rule of thumb is that at least 50% of a wall must be open to another room to consider that room as part of the kitchen. The following steps provide instructions for measuring room volumes of simple rectangular or circular rooms. If a room has a different shape, then the volume should be calculated according to the geometry of that space.

Equipment required

- Measuring tape
- Sonic distance meter (optional)
- Stepstool or ladder (optional)

Procedure

1) Determine the shape of the room. If the kitchen is rectangular, follow the steps in "a)"; if the kitchen is circular, follow the steps in "b)". If the shape of the kitchen requires a different calculation (e.g., if the kitchen has a trapezoidal roof or multiple rectangular volumes), then the geometries should be calculated as necessary specifically for that kitchen.

   a) Use the measuring tape to measure the following dimensions for a **rectangular kitchen**:
      i) Kitchen length – from front to the back
      ii) Kitchen width – from side to side
      iii) Minimum height – minimum distance from ceiling to floor
      iv) Maximum height – maximum distance from ceiling to floor
      v) The volume can then be calculated as:

$$Volume = length * width * \left[\frac{max\ height + min\ height}{2}\right]$$

Support materials: Input Data

https://worldhealthorg.shinyapps.io/HAPmodelinputdata/

World Health Organization

Database of input variables for the WHO Household Multiple Emission Sources (HOMES) and Performance Targets (PT) Models

Air Exchange Rate Data | Kitchen Volume Data | Cooking Time Data | Emissions Rate Data | Reference and Summary Data Downloads | About

Overview

This website provides the model input data needed to run the WHO HOMES (Household Multiple Emission Sources) and Performance Target (PT) Models

---

Select a Sampling Region

Please use the tabs at the top to see available data for each variable. By default, all available selections are made. Select multiple by using control+click (PC) or option+click (Mac).

Africa
Americas
South-East Asia

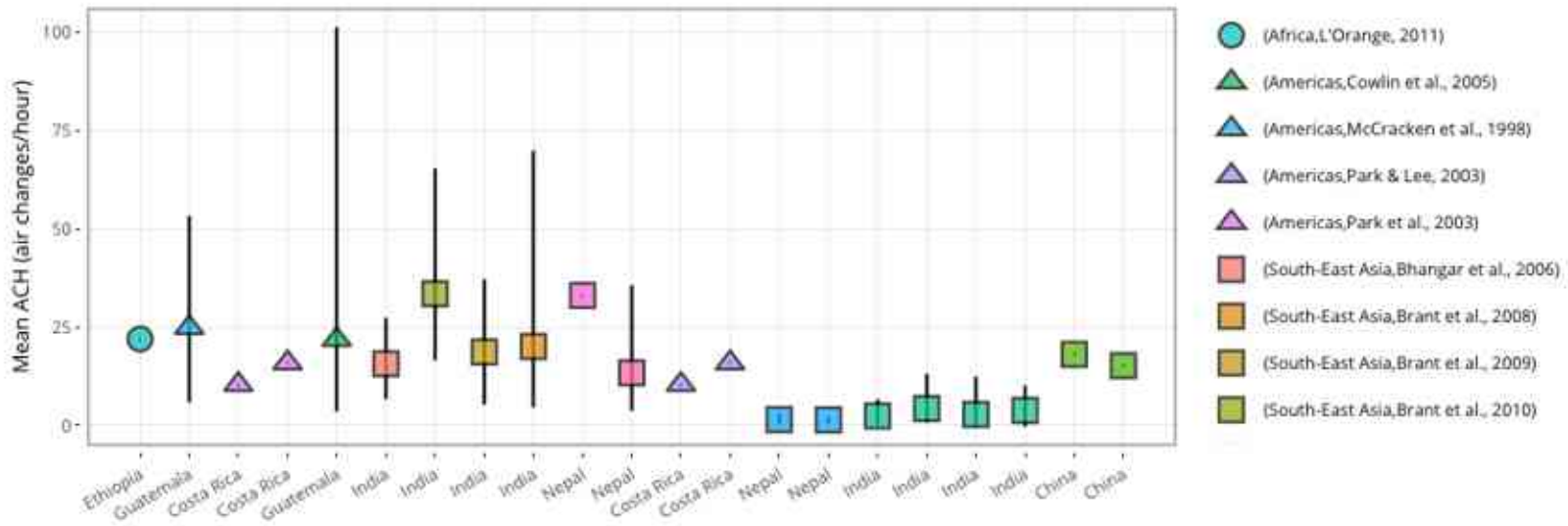
About

The website was designed by Berkeley Air Monitoring Group for the World Health Organization. Please contact WHO at householdenergy@who.int with questions or to share any additional data sources.

Air Exchange Rate

Error bars represent the minimum and maximum from literature-derived ranges, dots represent arithmetic means

Click on the camera icon above the figure to download an image of the data



Additional notes

Tools are a compliment to the ISO standards

Available for countries or organizations which want to develop context-specific targets or explore implications of different household energy scenarios

Requires a degree of technical capacity (ideally laboratories, academic/research groups can be involved)

Default voluntary performance targets are still relevant and help point progress towards cleaner solutions

Thank you!

Michael Johnson
mjohnson@berkeleyair.com

BERKELEY AIR
MONITORING GROUP

Clean Household Energy Solutions: World Health Organization's New Toolkit– Uganda's Experience

Richard Ebong ,richardebong@hotmail.com /richard.ebong@unbs.go.ug

EAST AFRICA


0 mi
200
0 km
400
SUDAN
DJIBOUTI
Gulf of Aden
Addis Ababa
ETHIOPIA
SOUTH SUDAN
Juba
SOMALIA
UGANDA
Mogadishu
DEMOCRATIC REPUBLIC OF THE CONGO
KENYA
Kampala
Lake Victoria
Nairobi
RWANDA
Kigali
BURUNDI
Bujumbura
TANZANIA
Dodoma
ZAMBIA

Cookstoves and Fuels used in Uganda

- 3 stone open fire and wood are the traditional stoves and fuels used for cooking in Uganda
- Biomass contribute about 94% of all energy consumed.
  - wood fuel 80%,
  - charcoal 10%, and
  - crop residues 4%.

Clean cooking solutions available in Uganda

- Biomass stoves
- Biogas stoves
- Electric stoves
- LPG
- Solar

Cookstoves and Fuels used in Uganda

Traditional and improved cookstoves

Cookstoves and Fuels used in Uganda

Traditional and improved fuels

Challenges encountered in promoting clean cooking

- High cost of clean fuels and clean cooking technologies
- Awareness of risks involved in using traditional fuels and cooking technologies
- Availability of technologies especially in rural areas
- High cost of testing charges

Health impacts from cooking in Uganda

Indoor air pollution related to burning of solid biomass fuels in poorly ventilated kitchens leads to about 24,000 deaths/annum (Source: WHO 2018).

Other health impacts/risks

- Burns and scalds are very common, especially to children and women
- Burning of roofs and entire houses
- Snake bites, incidences of rape (while collecting fuels), bruises and injuries from carrying wood, overweight loads carried by children and women.

Brief history of standards development for cookstoves and fuels in Uganda

Development of standards in this sector began in 2007 with the development of the following standards:

1) US 765:2007, Wood charcoal and charcoal briquettes for household

2) US 761:2007, Energy efficiency stoves Household biomass stoves Performance requirements and test methods

(Low level of lake Victoria, high cost of electricity, and War)

Brief history of standards development for cookstoves and fuels in Uganda

These two standards have since been revised.

1.US 761:2019 , Household biomass stoves requirements

2.US 765 -1:2019, Solid biofuels - Specification - Part 1: Lump charcoal

3.US 765-2:2019, Solid biofuels - Specification - Part 2: Carbonized briquettes;

4. Other standards US 1642: 2016, Domestic biogas stoves

Specification

1. US 971:2019 Liquefied Petroleum Gases (LPG)

Current efforts to implement standards for clean cooking in UGANDA

1. Revised US 761:2007 and issued US 761:2019 , Household biomass stoves Requirements (incorporating *ISO/TR 19867-3:2018 Part 3: Voluntary performance targets for cookstoves based on laboratory testing)*
2. Revised US 765:2007 and separated
    1. 765 -1:2019, Solid biofuels - Specification - Part 1: Lump charcoal
    2. US 765-2:2019, Solid biofuels - Specification - Part 2: Carbonized briquettes
3. Adopted US ISO 19867 -1 2018 Standard test sequence for emissions and performance, safety and durability

Current efforts to implement standards for clean cooking in UGANDA

1. Uganda proposed work item institutional cookstoves for development by ISO/TC285,
2. In the final stage of adopting ISO/FDIS 19869, Clean cookstoves and clean cooking solutions field testing methods for cookstoves
3. Development of sector codes of practice and Sensitization of stakeholders about clean cooking and the importance of standards in the sector.

Current efforts to implement standards for clean cooking in UGANDA

1. Private sector engagements and trainings
2. Many Certification applications are in the process one certified brand
3. Certification of biomass cookstoves and briquettes
4. Testing centers recognized under UNBS Laboratory recognition scheme - Government and Private schemes UNBS, CREEC, CIRCODU, Nyabyeya, Chemiphar

Current efforts to implement standards for clean cooking in UGANDA

Current efforts to implement standards for clean cooking in UGANDA

1. Private sector engagements and trainings
2. Many Certification applications are in the process
    1. One local manufacture certified for cookstove and briquettes
3. Certification of biomass cook stoves and briquettes
4. Development of Testing centers - under UNBS Laboratory recognition scheme - Government and Private schemes :UNBS, CREEC, CIRCODU, Nyabyeya, Chemiphar
5. Awareness creations


USE FIREWOOD OR CHARCOAL
SAVE 50%
UGASTOVE
SIMOSHI
ZONGSHEN

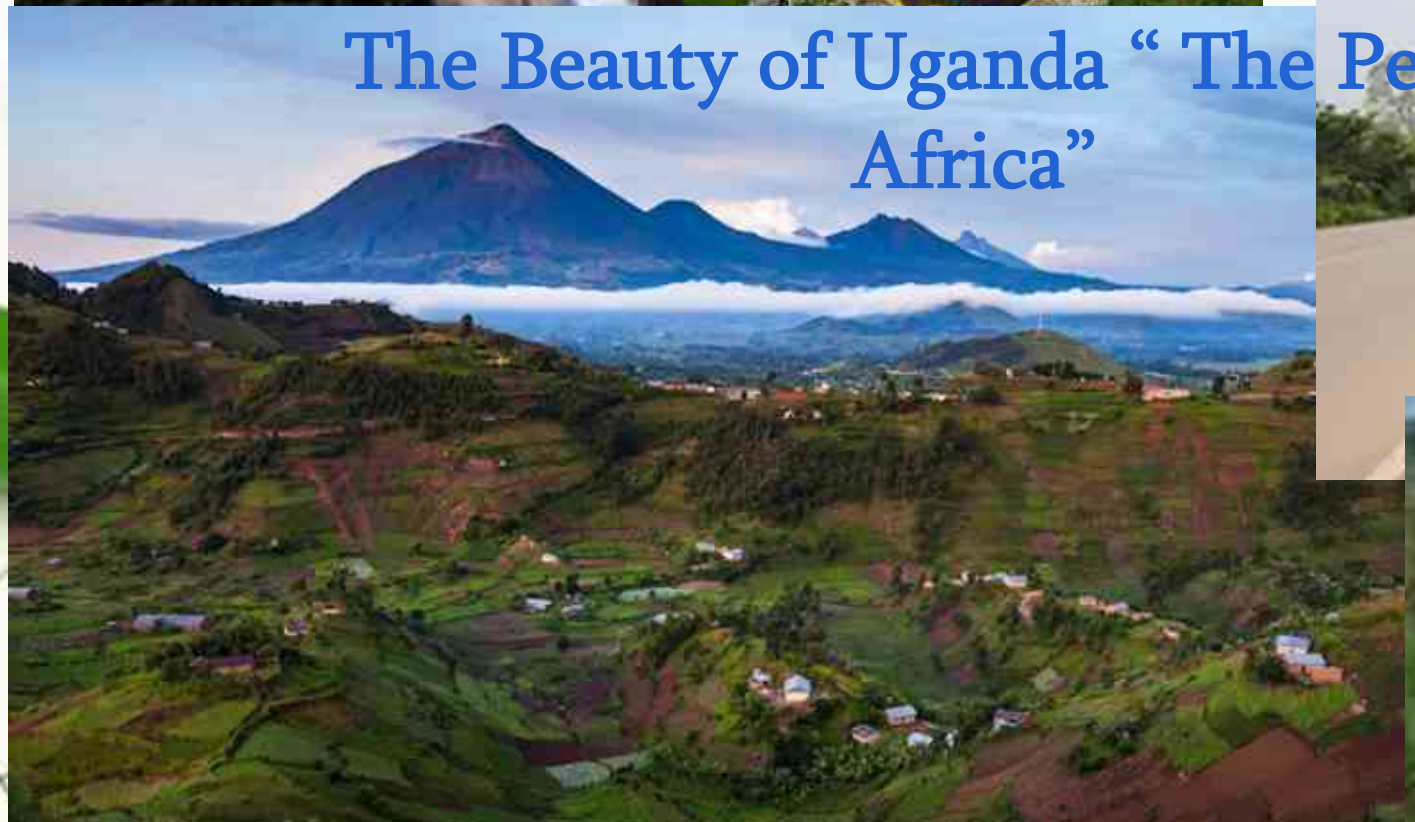

green
ervation Solutions
PORTICO ENERGY

Interventions Moving forward

Intervention needed in terms of support to Micro Small and Medium Enterprises to meet standards.

1. Enabling MSMEs to access affordable testing services for the related products
2. Capacity building in for onsite and offsite Technical guidance
3. Continues Consumer awareness campaigns

The Beauty of Uganda " The Pearl of Africa"



Thank you
For your kind Attention

Question & Answer

You are in ‘listen only’ mode

Type your question here

Submit your question by clicking here

Thank you for joining the ASHES webinar:

CLEAN HOUSEHOLD ENERGY SOLUTIONS: WORLD HEALTH ORGANIZATION'S NEW TOOLKIT

Brought to you by Colorado State University & Berkeley Air Monitoring Group

Contact us at erhs_ashes@mail.colostate.edu or find us on our website ashes-csu.org

Colorado State University

Berkeley Air Monitoring Group