Bioethanol: An Opportunity to Improve Health and the Environment

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Roadmap

1. Hazards associated with cooking with solid fuels and impact on health

2. Impact on the environment and climate

3. Impact of transitioning to clean fuels (i.e. bioethanol) and specific benefits

1.
Hazards Associated with Biomass Cooking and Impact on Health

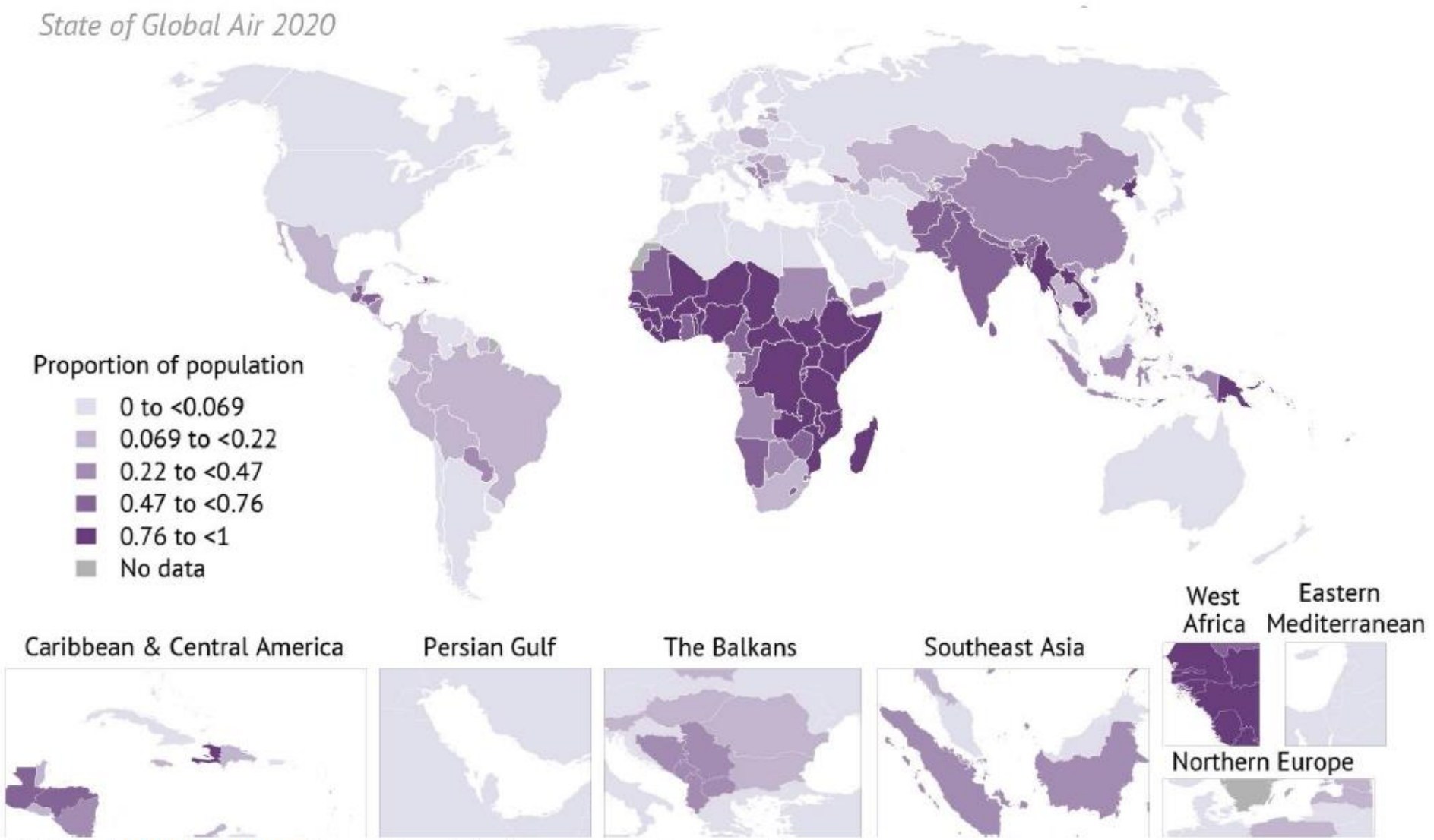
Household Air Pollution (HAP):

Pollution from of biomass (firewood or charcoal) for cooking and heating

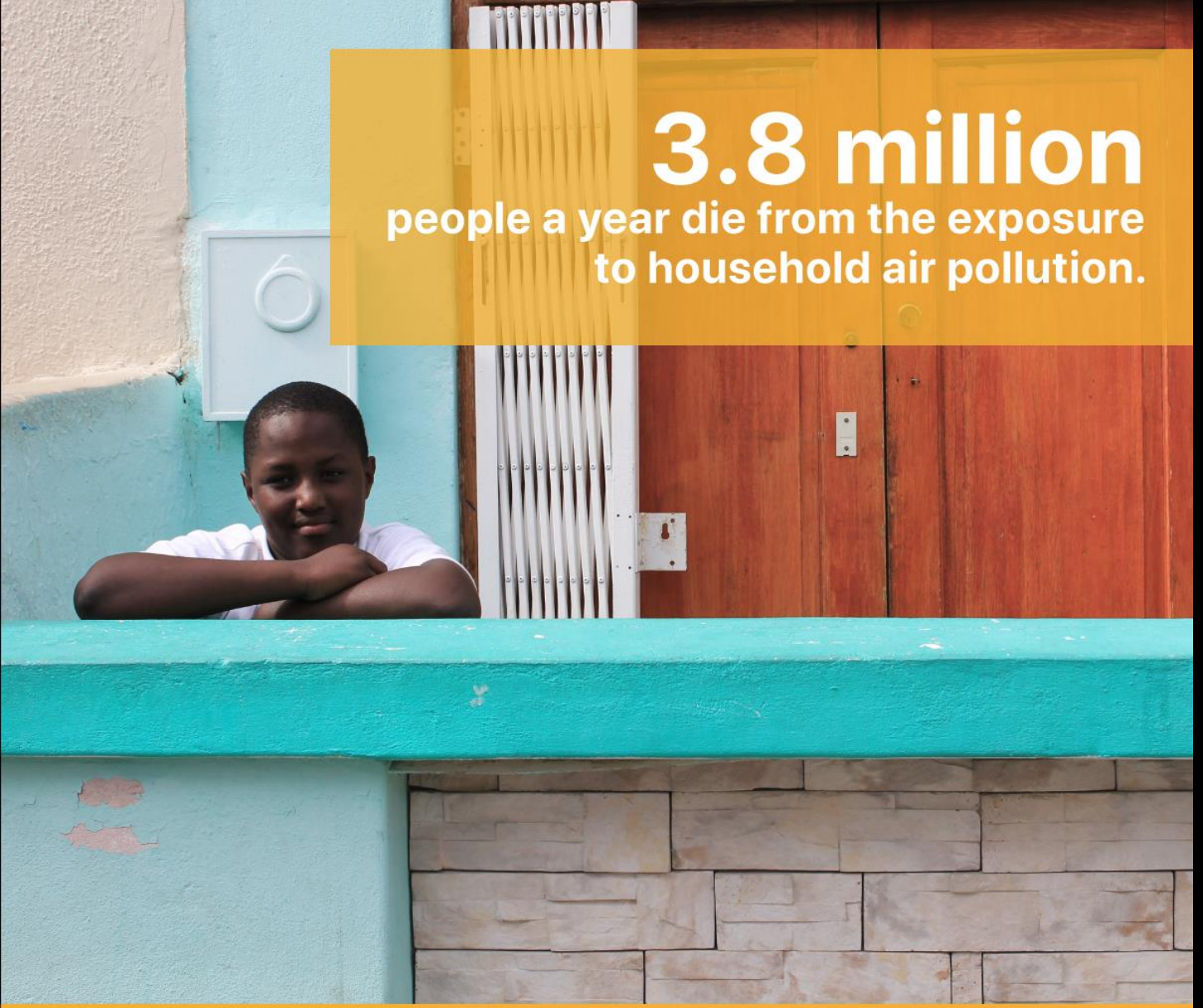
Burden is primarily on low and middle income countries

Primarily impacts women and children

FIGURE 8 Global map of the proportion of each country's population cooking with solid fuels in 2019.



Health Effects Institute. 2020. State of Global Air 2020. Special Report.



Is the 10th leading risk factor for disease

(2019 Global Burden of Disease)

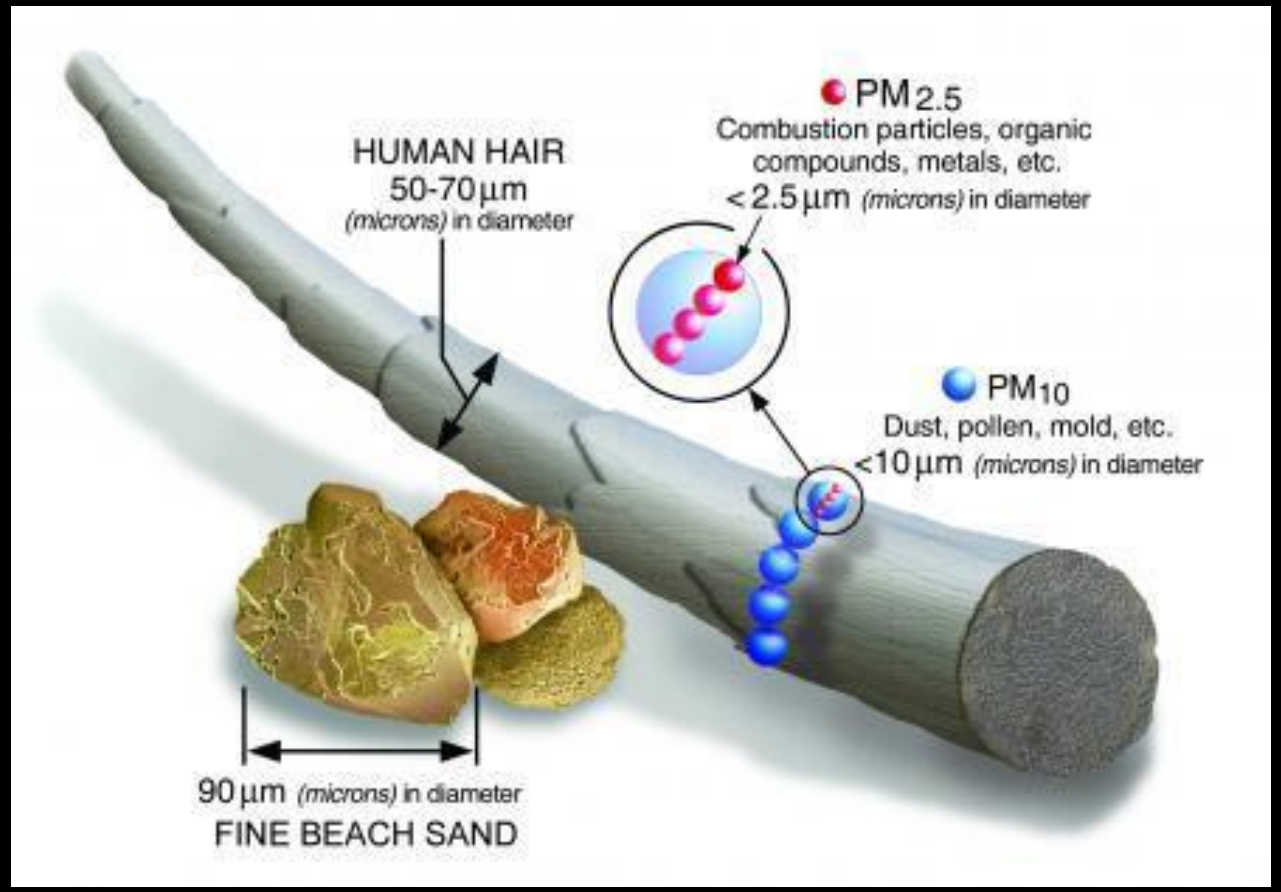
4.3 Million Deaths a year from ambient air pollution

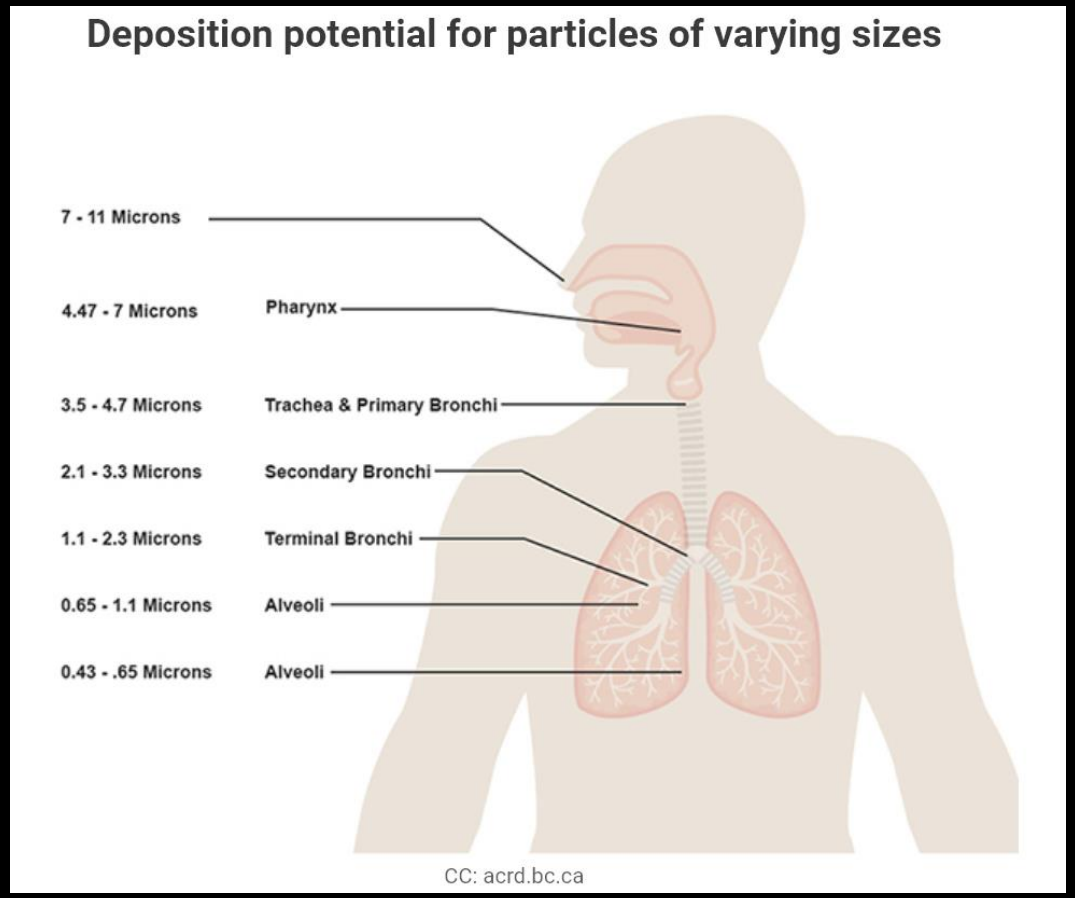
3 Million Deaths a year from household air pollution

Components of HAP

- Gases
  - Carbon monoxide
- Particulate Matter
  - Coarse PM (10µm)
  - Fine PM (2.5µm)
- Benzenes
- Polycyclic aromatic hydrocarbons (PAHs)
- Volatile organic compounds (VOCs)

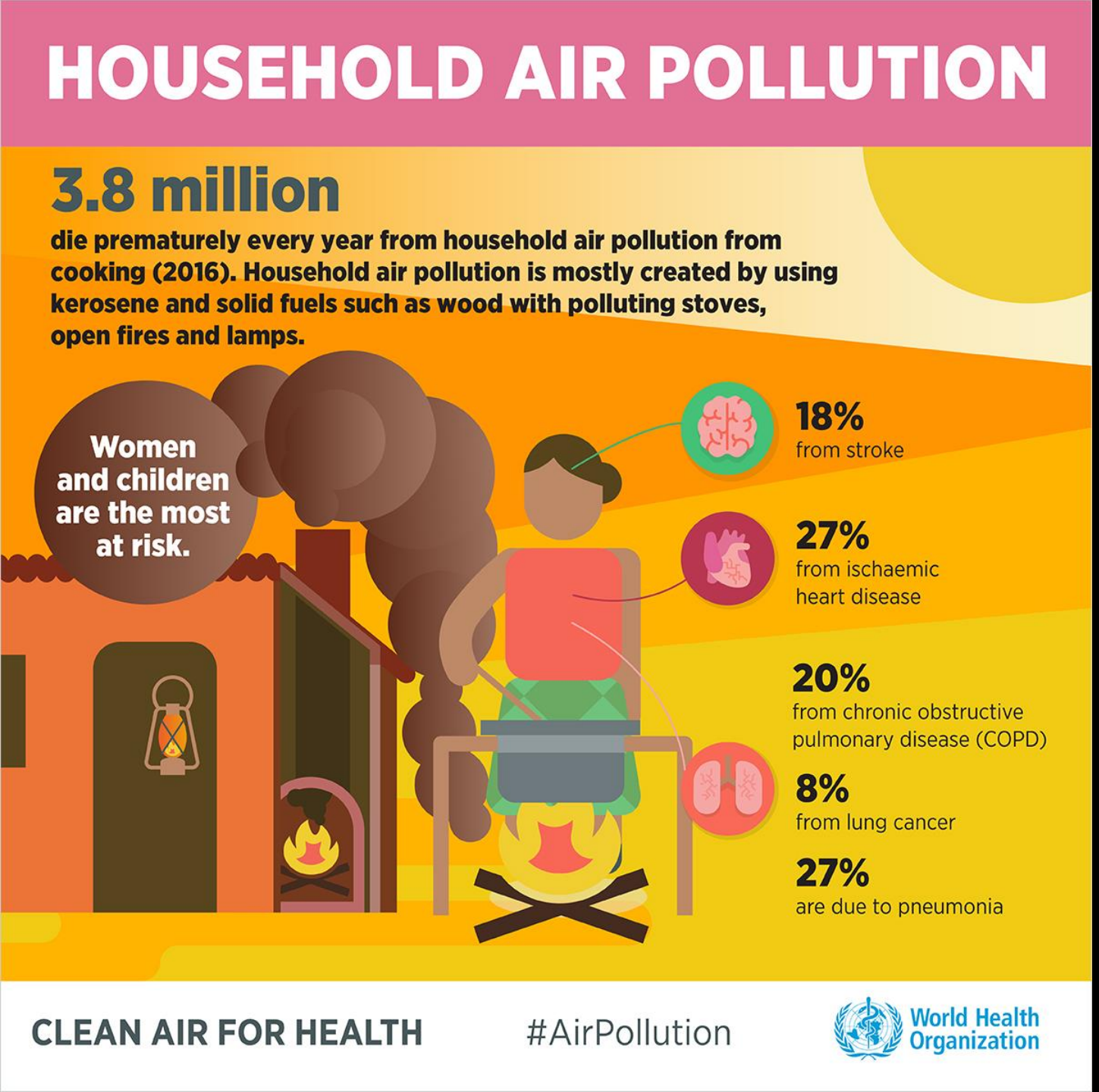
$PM_{2.5}$





https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

https://blog.gotopac.com/2019/03/25/particulate-matter-what-is-it-how-does-it-affect-our-health/

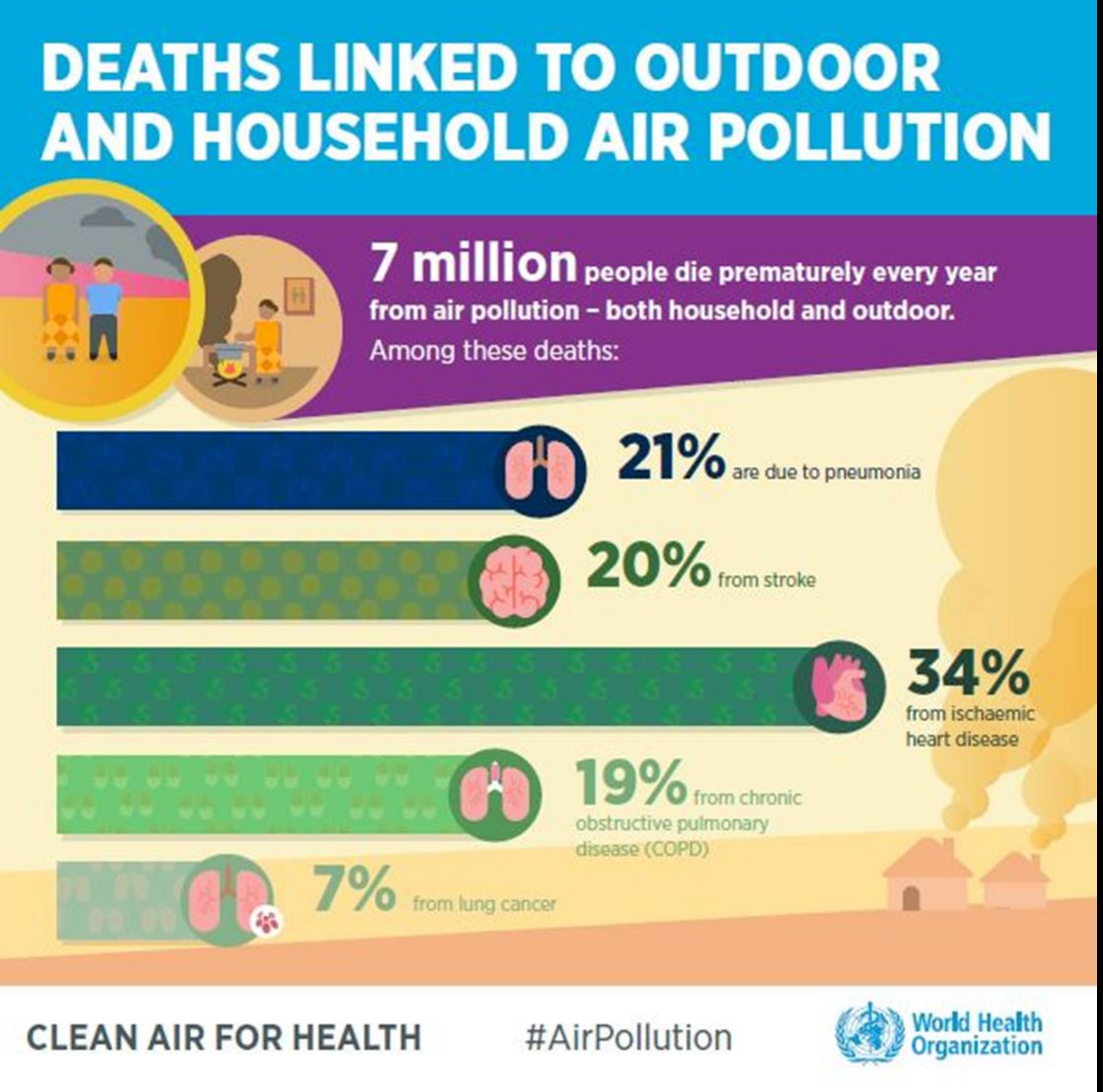


Epidemiologic Evidence

Children bear burden primarily from:

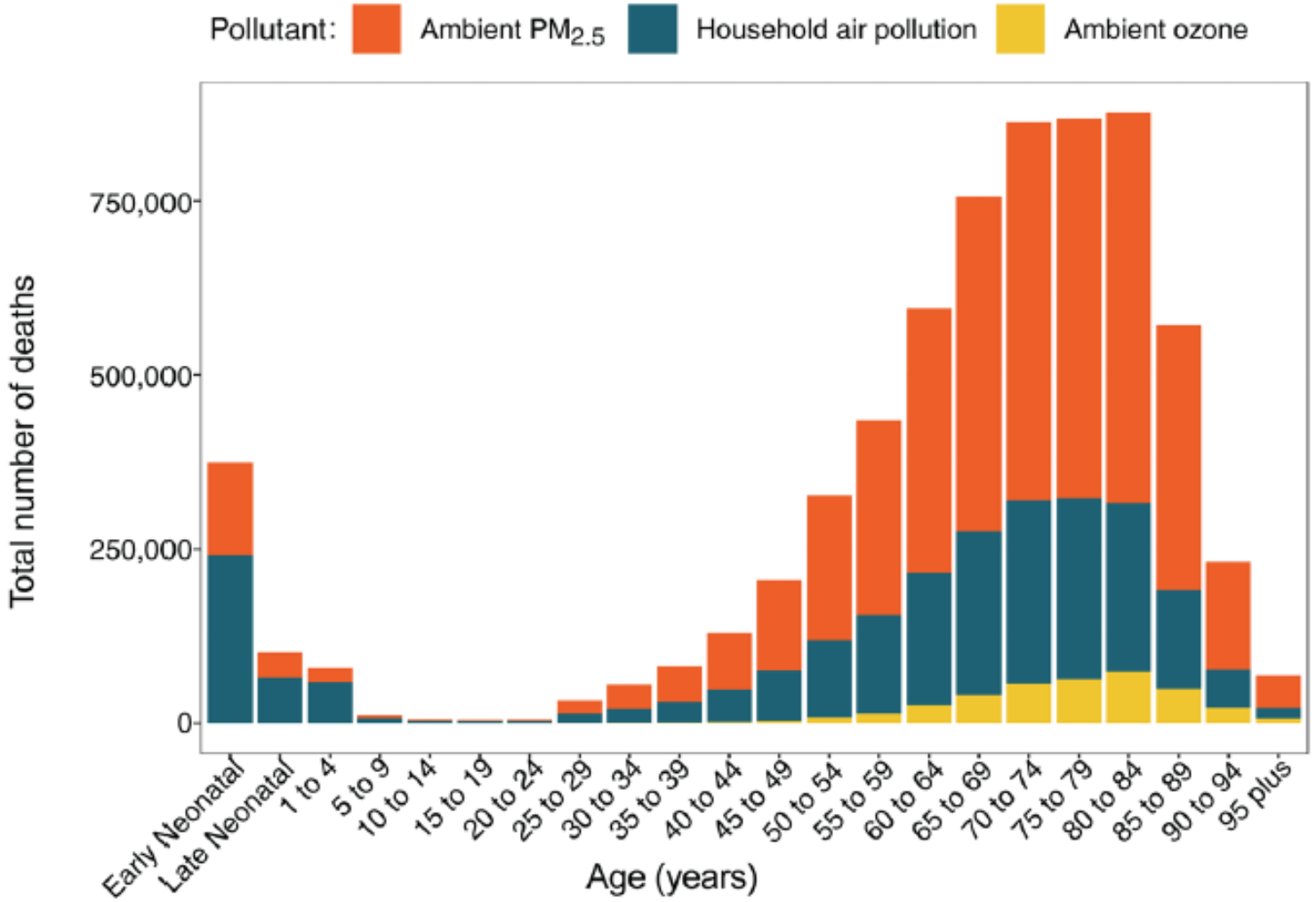
- Pneumonia
- Lower respiratory track infections (LRIs)

Emerging evidence for pregnancy complications and pre-term and low-weight births



Ambient (outdoor) and household air pollution combine to increase risk

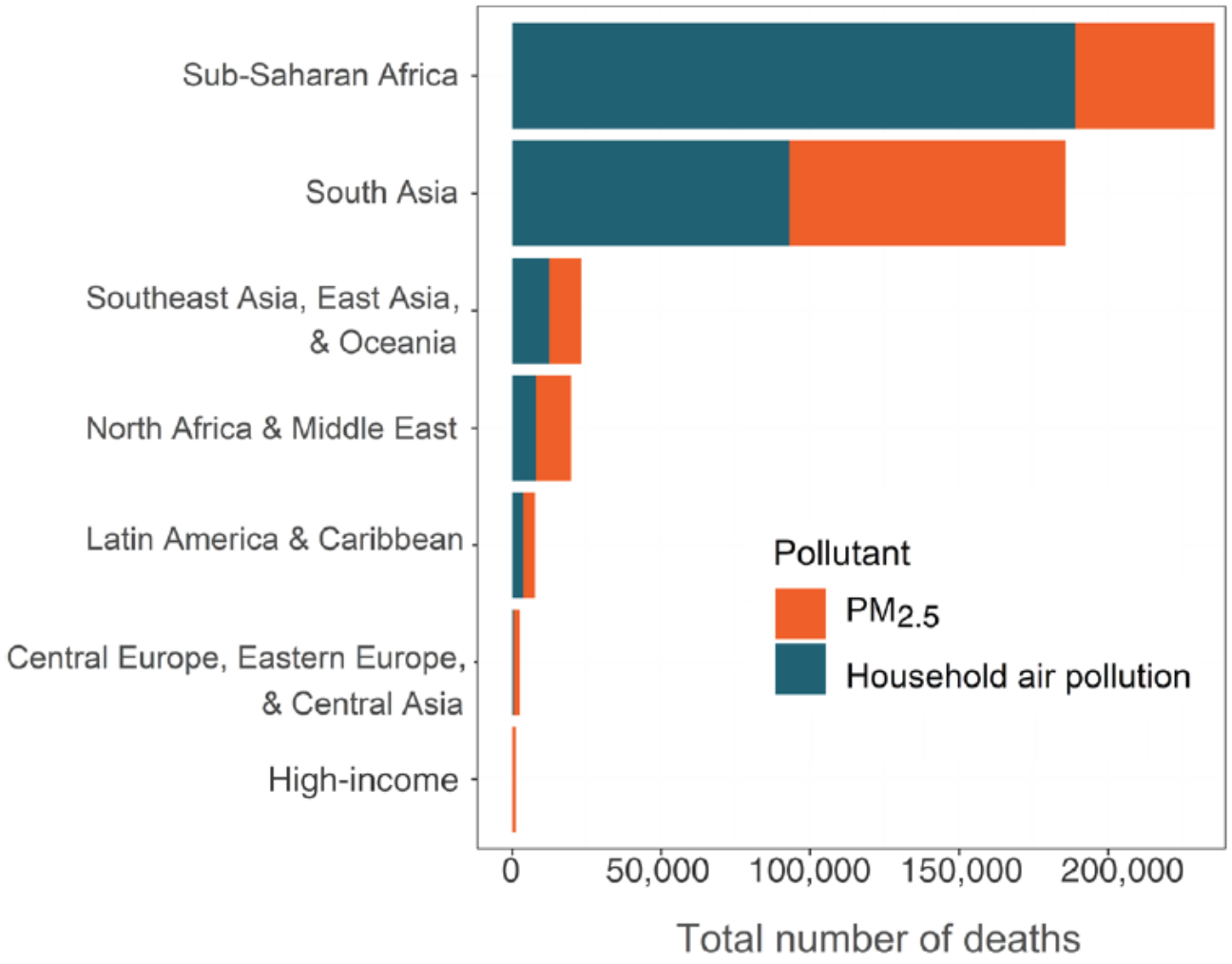
FIGURE 14 Distribution of global deaths in 2019 attributable to $PM_{2.5}$, ozone, and household air pollution by age (years, except early neonatal [0 to 6 days] and late neonatal [7 to 27 days]).



Deaths are not evenly distributed; there is variation across different age groups

Health Effects Institute. 2020. State of Global Air 2020. Special Report.

FIGURE 25 Deaths attributable to particulate matter in 2019 among babies in their first month of life in the GBD Super Regions.



Neonatal deaths attributable to air pollution are highest in Sub-Saharan Africa.

64% of these deaths are attributable to household air pollution

Health Effects Institute. 2020. State of Global Air 2020. Special Report.

Among children 0-9, household air pollution is the 4th leading risk factor for DALYs (disability-adjusted life years)

It is 1st in environmental risk factors; above unsafe water and sanitation

B 0–9 years

Leading risks 1990	Percentage of DALYs 1990	Leading risks 2019	Percentage of DALYs 2019	Percentage change in number of DALYs, 1990–2019	Percentage change in age-standardised DALY rate, 1990–2019
1 Child wasting	24·7 (20·7 to 28·9)	1 Low birthweight	28·9 (27·3 to 30·4)	−43·3 (−51·8 to −33·0)	−42·6 (−51·2 to −32·2)
2 Low birthweight	23·1 (22·1 to 24·1)	2 Short gestation	24·7 (23·3 to 26·1)	−41·2 (−49·6 to −30·2)	−40·4 (−49·0 to −29·3)
3 Short gestation	19·0 (18·1 to 19·9)	3 Child wasting	14·8 (12·3 to 17·3)	−72·9 (−78·4 to −66·3)	−73·6 (−79·1 to −67·3)
4 Household air pollution	11·2 (8·7 to 14·2)	4 Household air pollution	7·7 (6·0 to 9·5)	−68·8 (−75·2 to −60·6)	−68·9 (−75·4 to −60·9)
5 Unsafe water	11·0 (8·5 to 13·3)	5 Unsafe water	7·7 (5·9 to 9·4)	−68·3 (−75·8 to −57·4)	−68·9 (−76·4 to −58·6)
6 Child underweight	10·4 (8·2 to 13·3)	6 Unsafe sanitation	5·1 (4·3 to 6·0)	−72·0 (−78·7 to −62·0)	−72·5 (−79·3 to −63·0)
7 Unsafe sanitation	8·2 (6·8 to 9·7)	7 Handwashing	4·5 (3·2 to 5·8)	−66·0 (−72·9 to −57·0)	−66·7 (−73·6 to −58·0)
8 Child stunting	6·2 (3·2 to 10·5)	8 Child underweight	4·4 (3·6 to 5·4)	−80·8 (−85·2 to −75·3)	−81·4 (−85·7 to −76·1)
9 Handwashing	6·0 (4·3 to 7·6)	9 Ambient particulate matter	4·0 (2·8 to 5·2)	−23·3 (−45·9 to 11·5)	−20·5 (−46·3 to 10·8)
10 Non-exclusive breastfeeding	3·8 (2·8 to 4·9)	10 Child stunting	2·7 (1·3 to 4·8)	−80·3 (−85·8 to −74·5)	−81·1 (−86·4 to −75·5)
11 Ambient particulate matter	2·3 (1·3 to 3·9)	11 Non-exclusive breastfeeding	2·4 (1·8 to 3·0)	−72·1 (−77·8 to −65·3)	−72·1 (−77·8 to −65·3)

GBD 2019 website see http://ghdx.healthdata.org/ gbd–2019

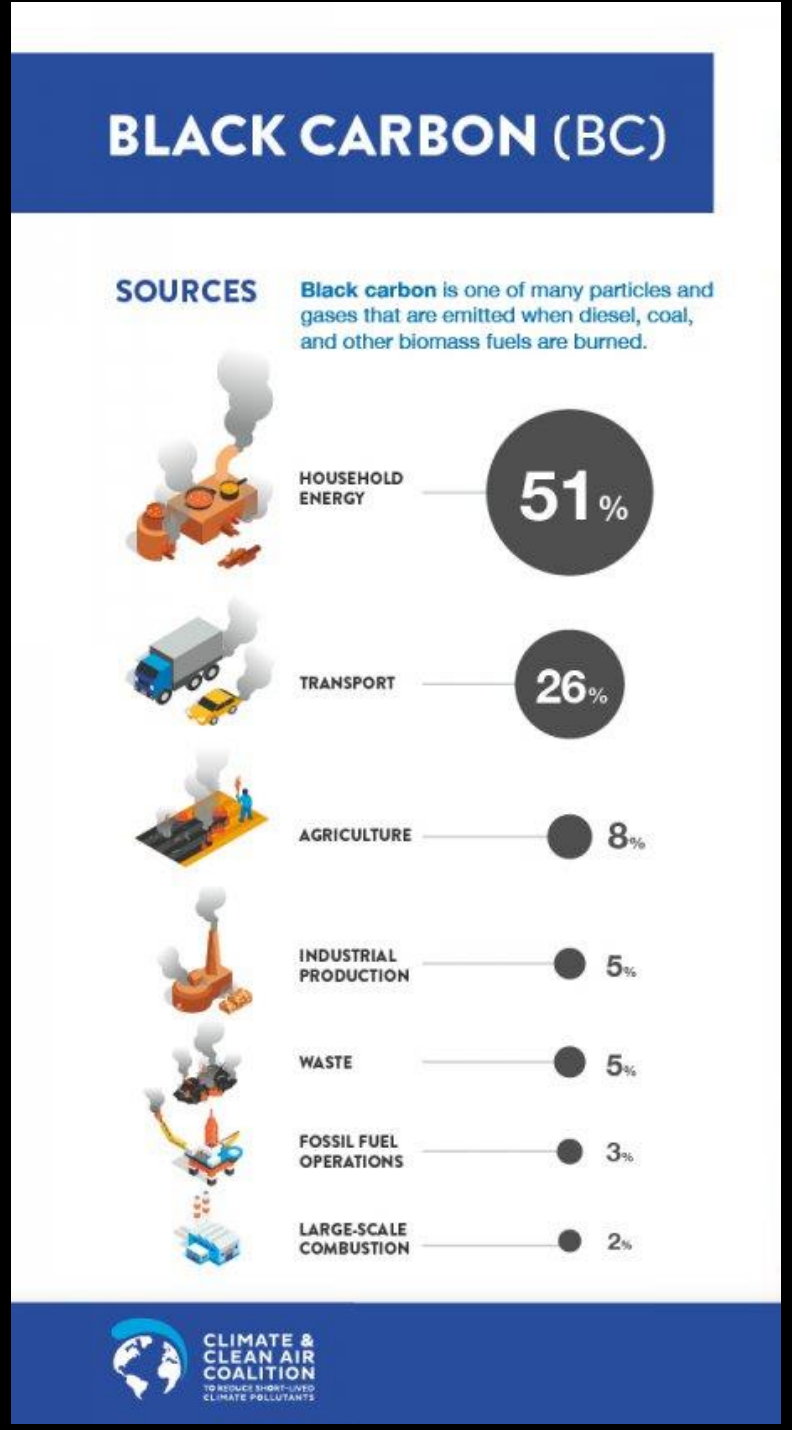
2.
Impact of Biomass Cooking on Environment and Climate

Maybe household air pollution is only a concern for rural populations?

Unfortunately, no.

Use of biomass fuels for cooking results in deforestation and environmental degradation

It is a primary contributor to climate change, which when combined with urban air pollution, greatly impacts urban settings



Household combustion emits half of all global black carbon emissions (a part of the fine PM)

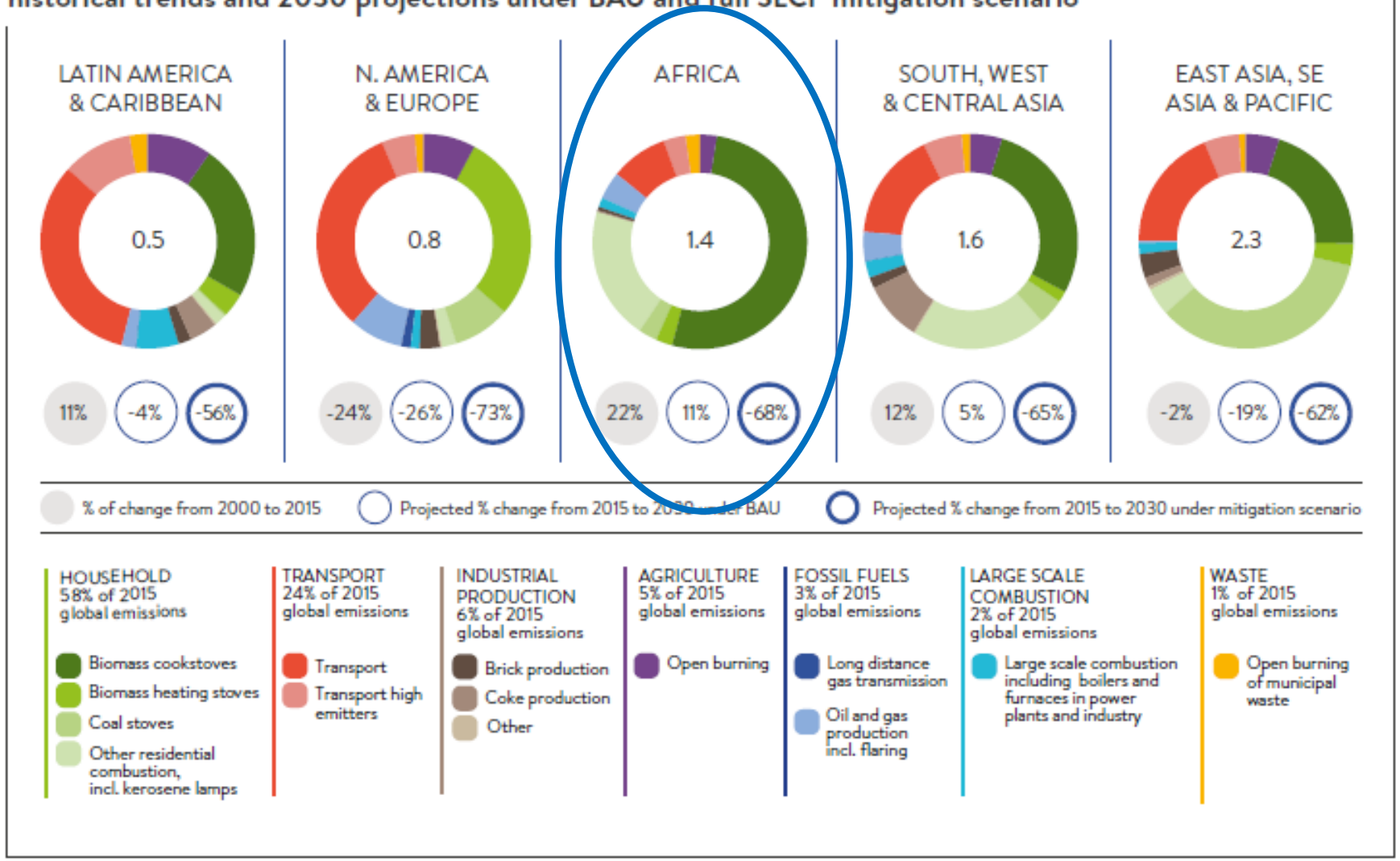
Black carbon has a per-unit warming capacity of 460 – 1,500 times that of carbon dioxide

It is the largest contributor to climate change after carbon dioxide

https://www.ccacoalition.org/en/slcps/black-carbon

BLACK CARBON EMISSION TRENDS

2015 Black carbon emissions from main anthropogenic sources (in million tonnes) by region, historical trends and 2030 projections under BAU and full SLCP mitigation scenario



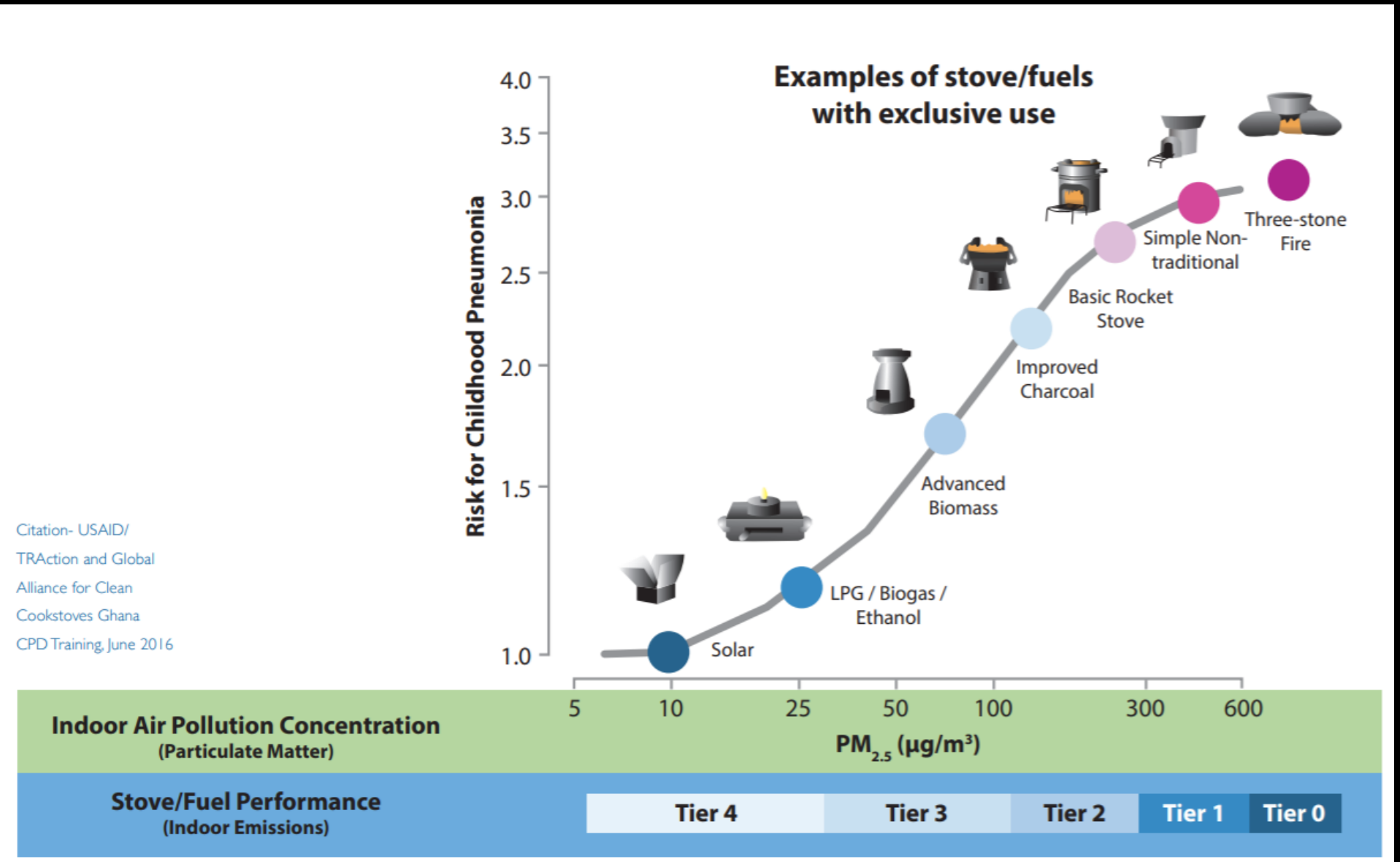
Source: IIASA GAINS, 2017

How do we reduce burden of disease from household air pollution and improve health?

Ideally, households would have access to electricity for cooking and heating.

Given the challenges to electrification, we can reduce the risk of disease and impact on the environment from household air pollution with “cleaner burning” fuel and stove technologies

3.
Opportunities and Benefits of Bioethanol



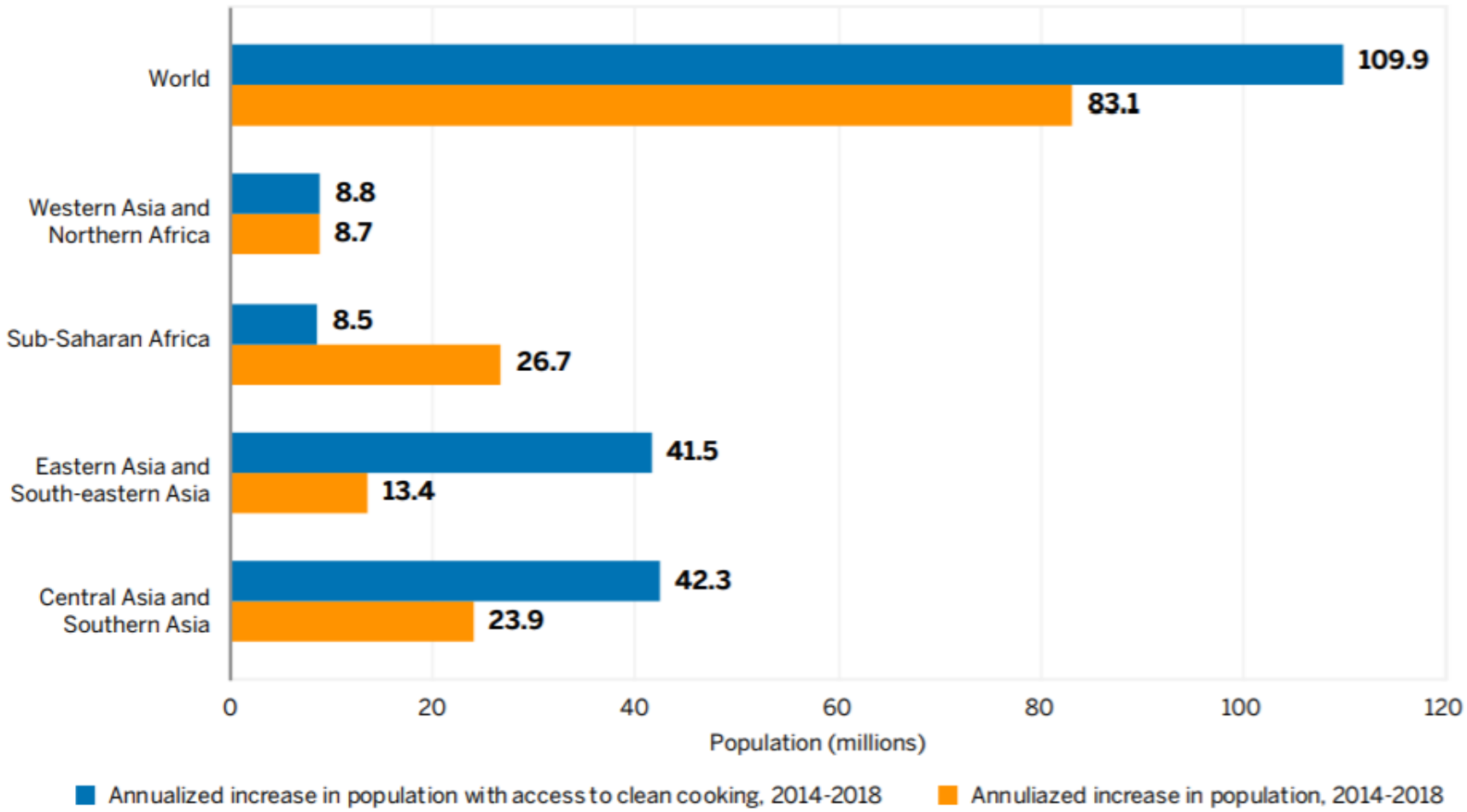
Citation- USAID/ TRAction and Global Alliance for Clean Cookstoves Ghana CPD Training, June 2016

Goal:

Reduce health and environmental burden by utilizing electricity or "cleaner" fuel and stove combinations

https://www.usaid.gov/sites/default/files/documents/1865/cookstoves-toolkit-2017-mod2-health-research.pdf

FIGURE 2.7 • Annualized increase in population and in the number of people with access to clean cooking over the period 2014–18, by region

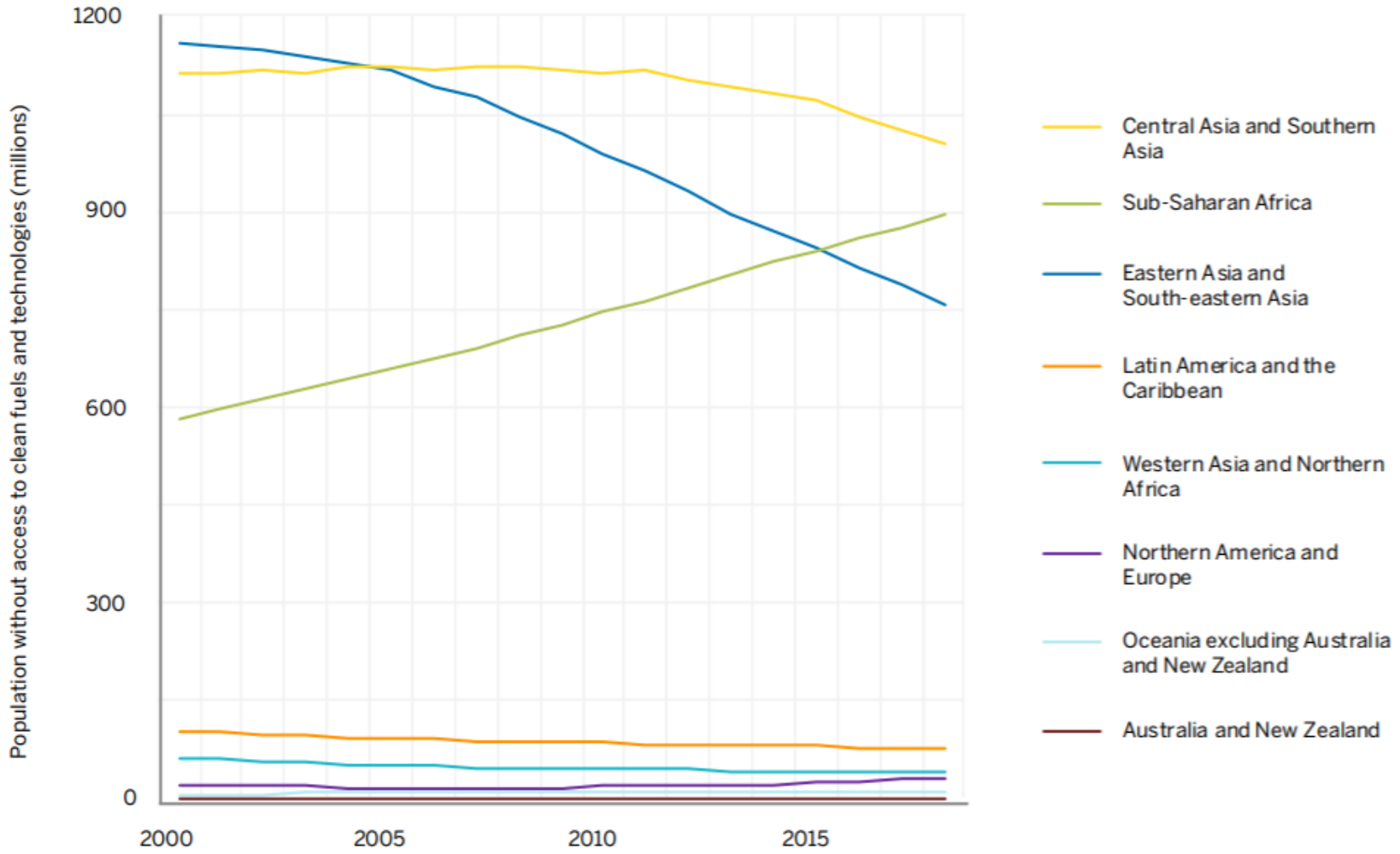


Source: WHO; UN population estimates.

Access deficit

IEA, IRENA, UNSD, World Bank, WHO. 2020. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank.

FIGURE 2.8 • Access deficits by region (population without access to clean fuels and technologies), 2000–18



Source: WHO.

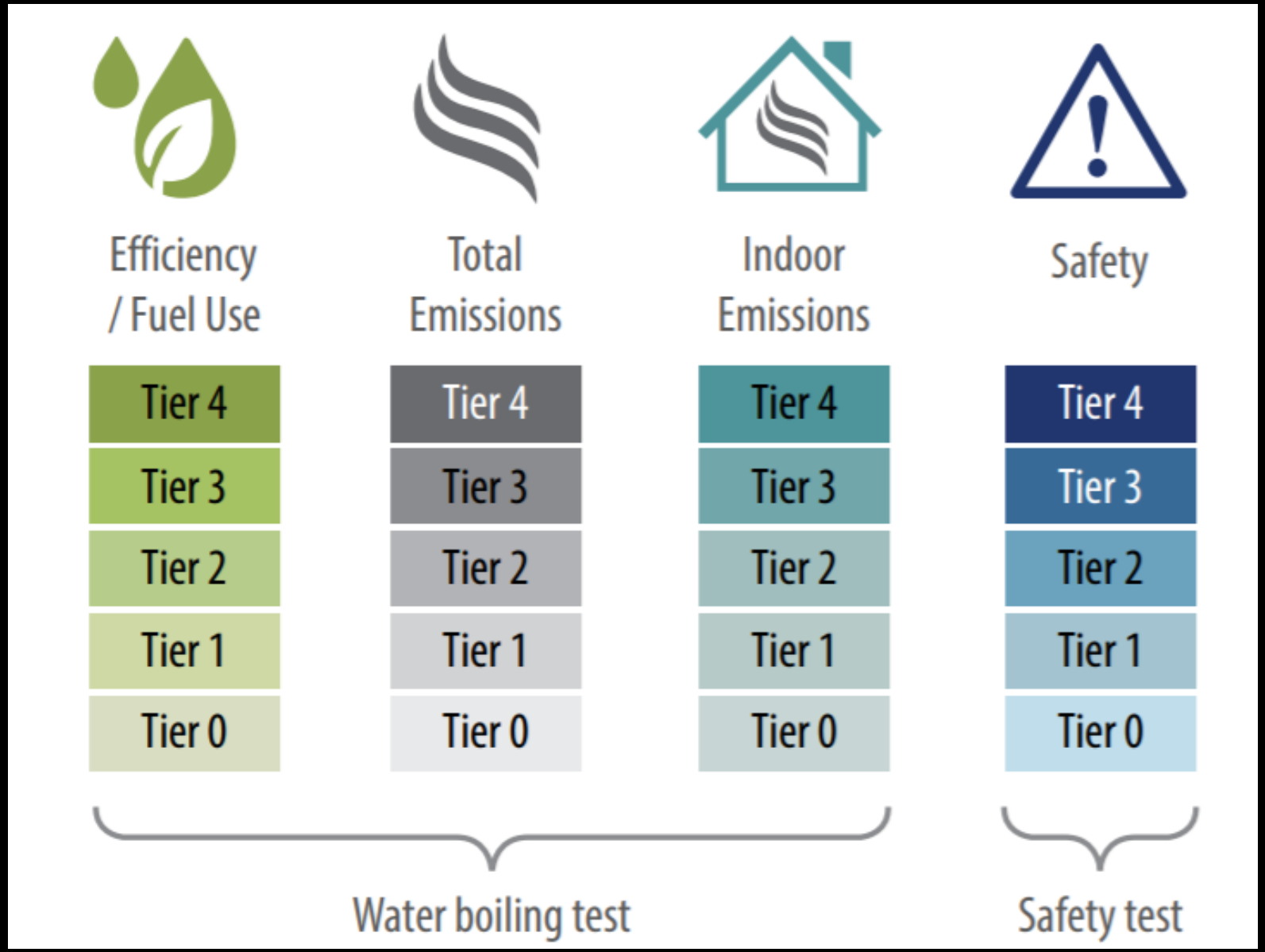
IEA, IRENA, UNSD, World Bank, WHO. 2020. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank.

Bioethanol:

An opportunity to reduce household air pollution, improve health, and the environment

Fuel and stove combinations

ISO Tiers



CleanCook Aluminum One-Burner (A1)

Manufacturer: Dometic (Pty) Ltd.

Website: http://www.dometic.com/enie/International/Site/CleanCook-Alcohol-Fueled-Stoves/CleanCook-product-range/

All stainless steel burner parts, body of aluminum, galvanized steel, aluminum. Single burner.

IWA tiers of performance

▼ show subtiers

Emissions	Efficiency	Indoor emissions	Safety
4	4	4	4

http://catalog.cleancookstoves.org

In research studies, ethanol stove interventions have reduced kitchen $PM_{2.5}$ by 82%

(compared to biomass)

(Pope et al. 2017)

https://img.chdrstatic.com/media/

https://motosafi.com/

Biofuels, such as ethanol may be carbon neutral

Some plants used to make ethanol absorb CO2 as they grow

Bioethanol also burns very cleanly

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Full length article

Effect of a clean stove intervention on inflammatory biomarkers in pregnant women in Ibadan, Nigeria: A randomized controlled study

Christopher O. Olopade, MD [a,b,*], Elizabeth Frank [a], Emily Bartlett [c], Donee Alexander, PhD [a], Anindita Dutta, PhD [a,b], Tope Ibigbami, MSc [d], Damilola Adu, MSc [d], John Olamijulo, MPH [d], Ganiyu Arinola, PhD [e], Theodore Karrison, PhD [f], Oladosu Ojengbede, MD [g]

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Science of the Total Environment

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Impact of prenatal and postnatal household air pollution exposure on lung function of 2-year old Nigerian children by oscillometry

Anindita Dutta [a], Mariam Alaka [b], Tope Ibigbami [c], Dayo Adepoju [c], Samuel Adekunle [c], John Olamijulo [c], Babatunde Adedokun [a], Oluwafunmilade Deji-Abiodun [a], Ryan Chartier [d], Oladosu Ojengbede [e], Christopher O. Olopade [a,b,*]

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ORIGINAL ARTICLE

Randomized Controlled Ethanol Cookstove Intervention and Blood Pressure in Pregnant Nigerian Women

Donee Alexander[1], Amanda Northcross[2], Nathaniel Wilson[3], Anindita Dutta[1,4], Rishi Pandya[5], Tope Ibigbami[6], Damilola Adu[6], John Olamijulo[6], Oludare Morhason-Bello[7], Theodore Karrison[8], Oladosu Ojengbede[7], and Christopher O. Olopade[1,4]

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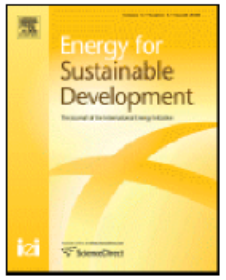
Energy for Sustainable Development



A case study of the ethanol CleanCook stove intervention and potential scale-up in Ethiopia☆

Megan L. Benka-Coker [a,*], Wubshet Tadele [b], Alex Milano [c], Desalegn Getaneh [b], Harry Stokes [c]

[a] Colorado State University, Department of Environmental and Radiological Health Sciences, 1681 Campus Delivery, Fort Collins, CO 80523, USA
[b] Gaia Association, Bole Sub City, Wereda 17, Kebele 23 House No 2003, P.O. Box 1460, 1250 Addis Ababa, Ethiopia
[c] Project Gaia, Inc., P.O. Box 4190, Gettysburg, PA 17325, USA

Energy is essential to achieving the 2030 Sustainable Development Goals and Paris Climate Agreement

SDG 7 calls for “ensuring access to affordable, reliable, sustainable and modern energy for all”

Key take-away messages:

1. Biomass burning for cooking impacts human health and the environment/climate change

2. Bioethanol is a cleaner burning fuel compared to traditional biomass

3. Bioethanol use for cooking is an incredible opportunity to reduce the burden of disease on populations and the impact of biomass burning on the environment