Feasibility study assessing the impact of biogas digesters on indoor air pollution in households in Uganda

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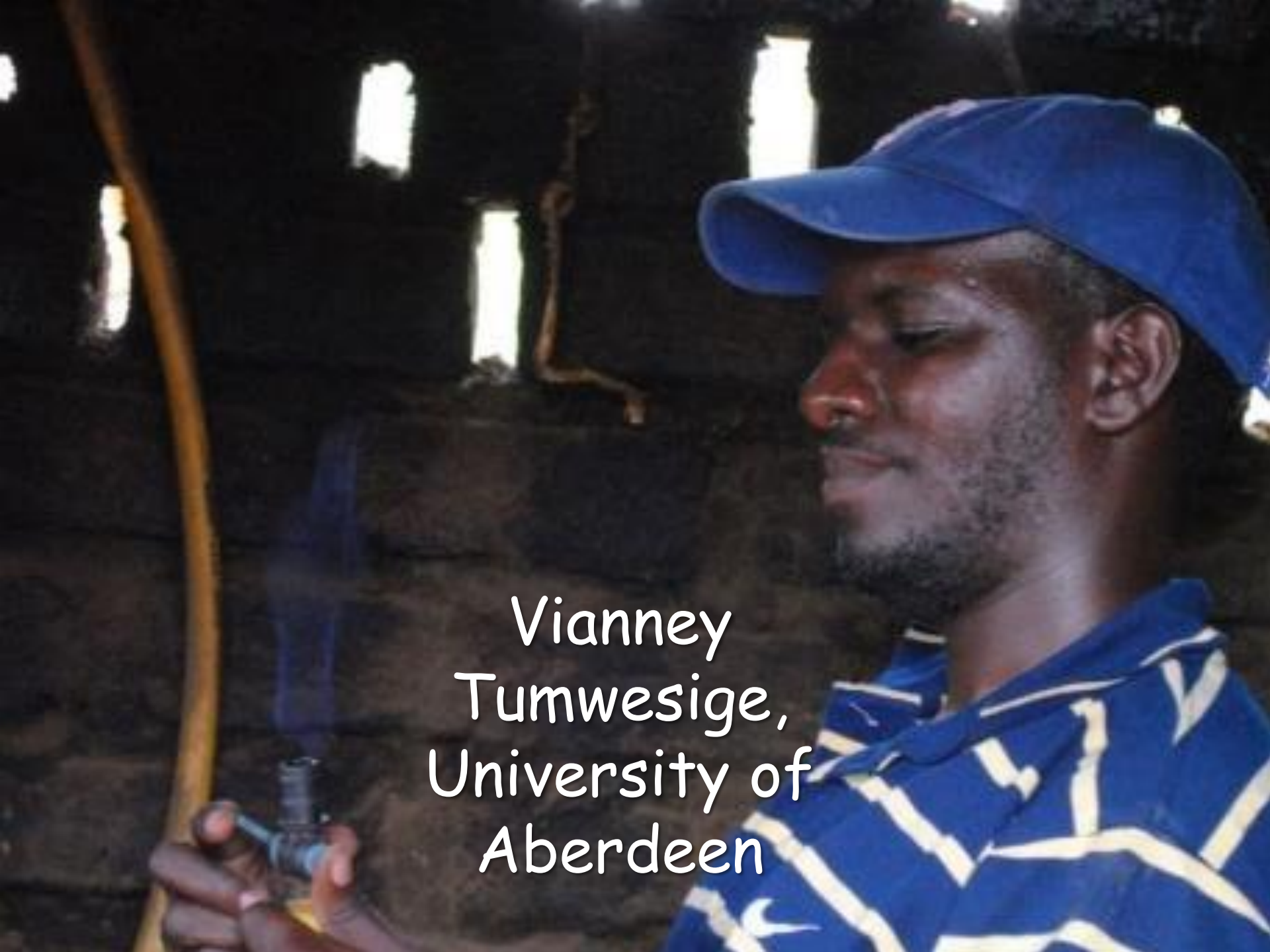
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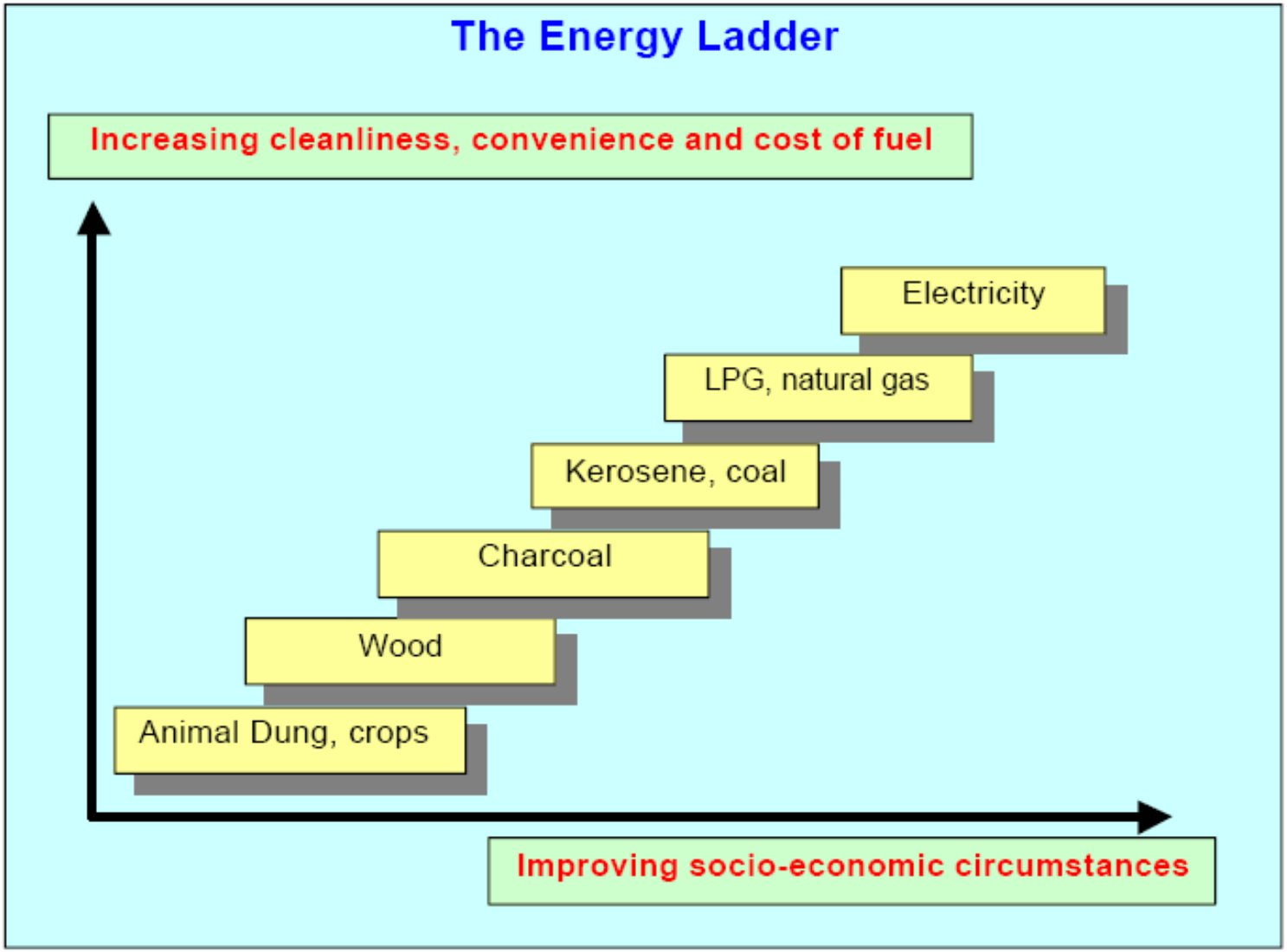
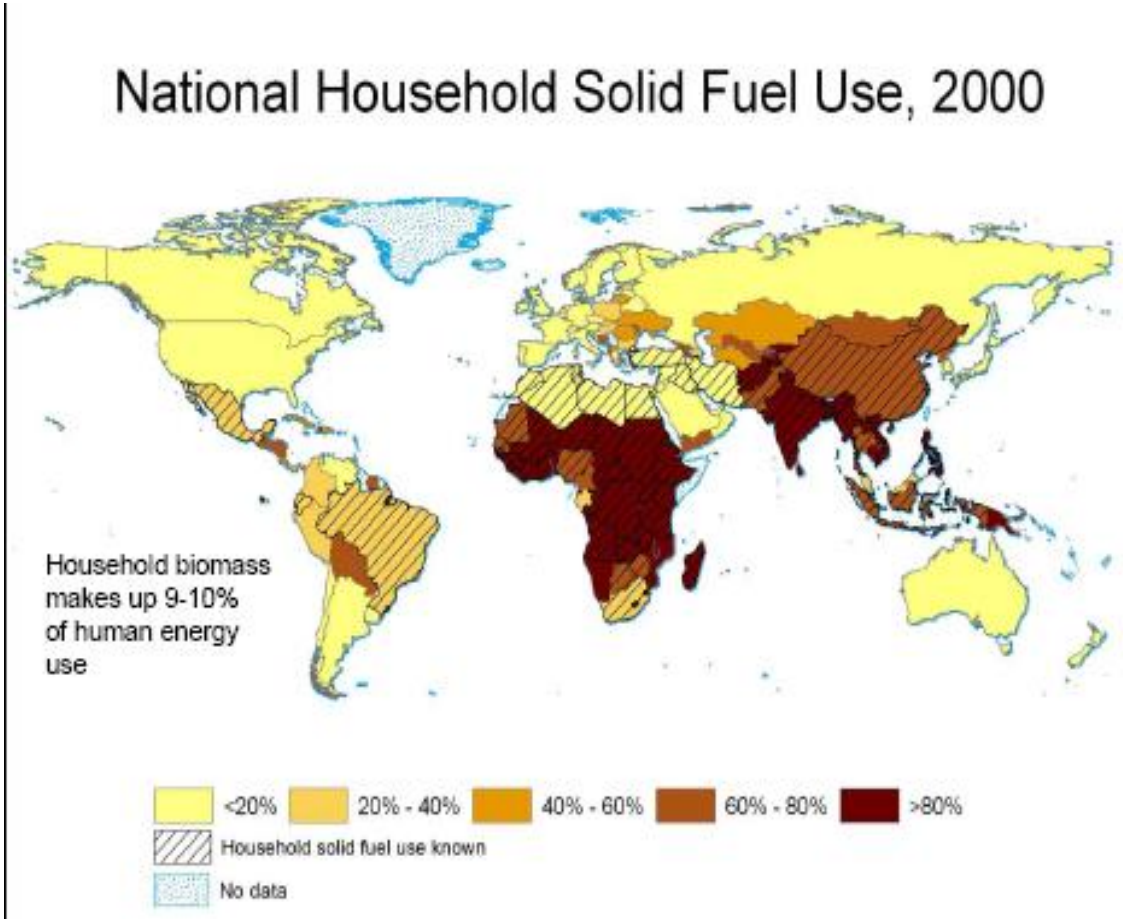
Biomass fuel use and poverty

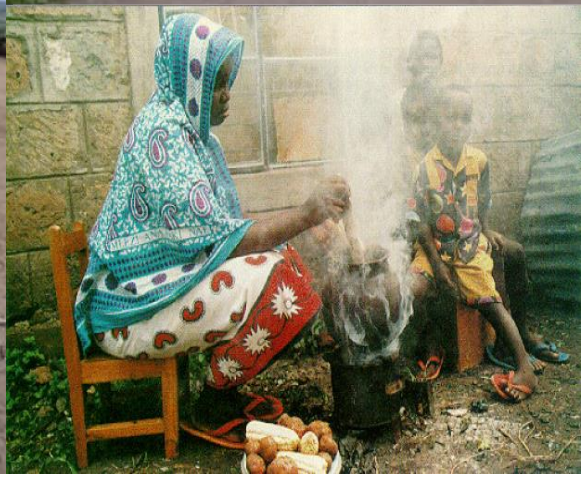


Environment & Health…

- Humans spend much of their time indoors
- 3 billion people globally exposed to biomass smoke in homes
- Link to pneumonia, lung cancer, chronic lung diseases
- Estimated leads to ~1.2 million premature deaths annually
- In Uganda only 1.3% of rural people have access to modern fuels



What do we mean by biomass?

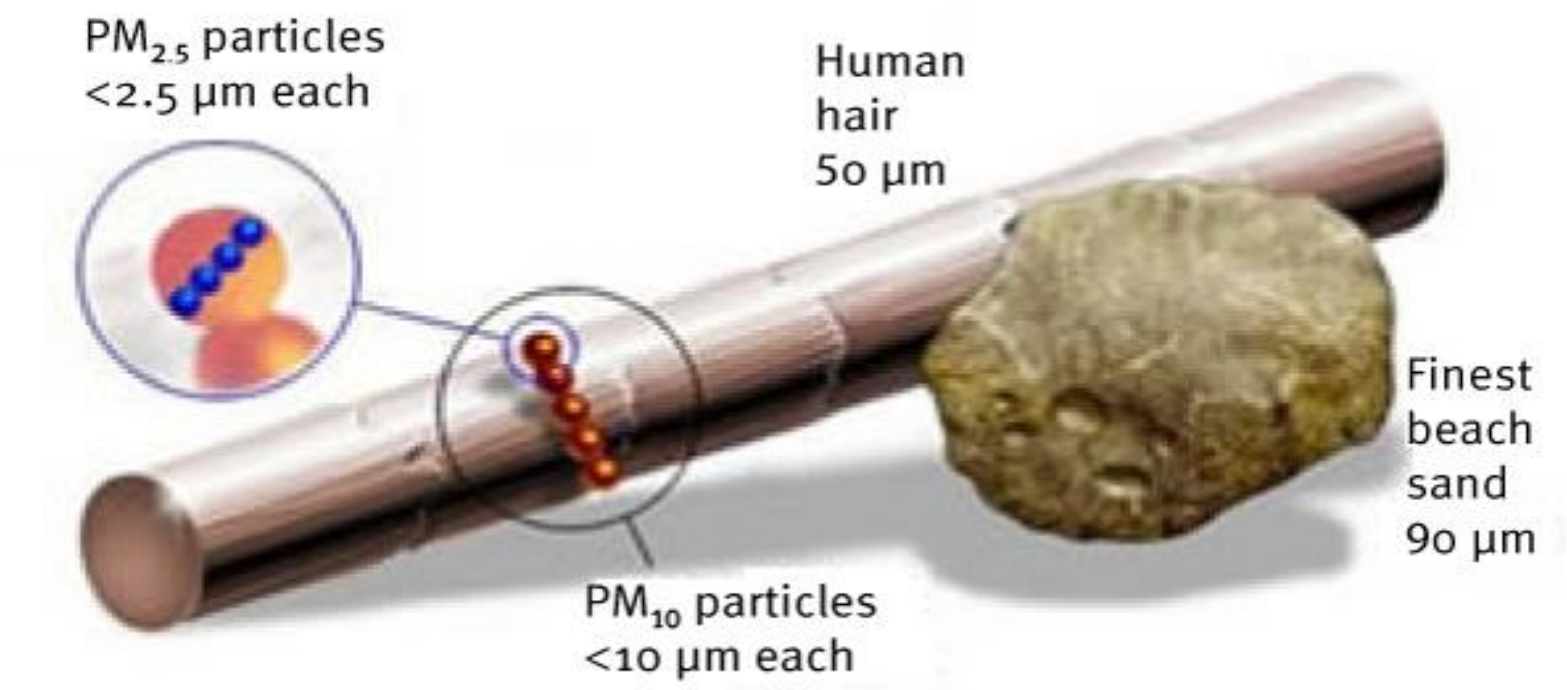


What are the pollutants in biomass smoke?

- Fine particulate matter ('smoke')
  - $PM_{2.5}$
  - PM_{10}
  - Inhalable dust
  - Respirable dust
- Carbon Monoxide (CO)
- Airborne endotoxin (inflammatory agent)
- Other chemicals (PAHs, Arsenic, Aldeyhdes, Nitric Oxides, Benzene. Sulphur Dioxide)

What is $PM_{2.5}$?

- Small particles inhaled into deep areas of the lung
- Epidemiological evidence that $PM_{2.5}$ air pollution is linked to respiratory and cardiovascular health effects



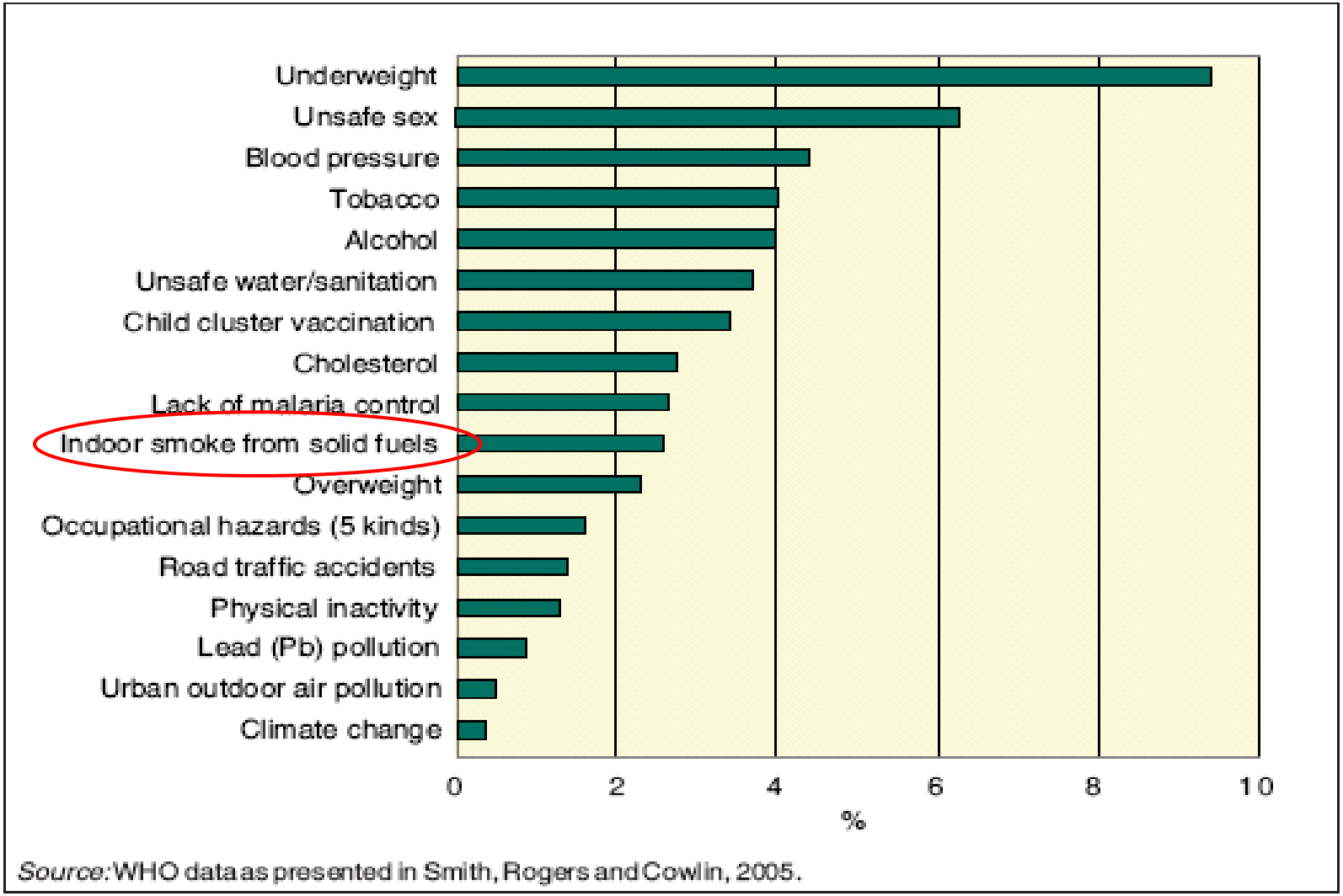
A summary of biomass smoke risk…

- Large increases in risks
- Large population exposure (3 billion people globally)
- Leads to ~1.2 million premature deaths annually

	Relative risk
• Acute lower respiratory tract infection	
children <5y	2.3 (1.9-2.7)
• Chronic obstructive pulmonary disease	
women >30y	3.2 (2.3-4.8)
men >30y	1.8 (1.0-3.2)
• Lung cancer	
women >30y	1.9 (1.1-3.5)
men >30y	1.5 (1.0-2.5)
• Asthma	
children 5-14y	1.6 (1.0-2.5)
>15y	1.2 (1.0-1.5)
• Cataracts	1.3 (1.0-1.7)
• Tuberculosis	
>15y	1.5 (1.0-2.4)

Estimated burden of disease for major risk factors

Measures as percentage of total healthy life years lost in the world in 2000



Air quality targets

…for fine particles $PM_{2.5}$ - US EPA Air Quality Index

$PM_{2.5}$ $\mu g/m^3$	AQI	Advice
35	Unhealthy for sensitive groups	Heart/lung disease and elderly/ children advised to reduce prolonged exertion
65	Unhealthy	Heart/lung disease/elderly/children avoid prolonged exertion; everyone reduce prolonged exertion
150	Very unhealthy	Heart/lung disease avoid all physical activity; everyone avoid prolonged exertion
250	Hazardous	Heart/lung disease remain indoors; everyone avoid physical activity

…for CO - WHO Air Quality Guidance

6ppm 24-hour mean

Methods

$PM_{2.5}$ and CO measured before and after installation of digesters in 9 household in Tiribogo, Uganda

Methods

Direct reading instruments used

$PM_{2.5}$

TSI AM510 Sidepak

CO

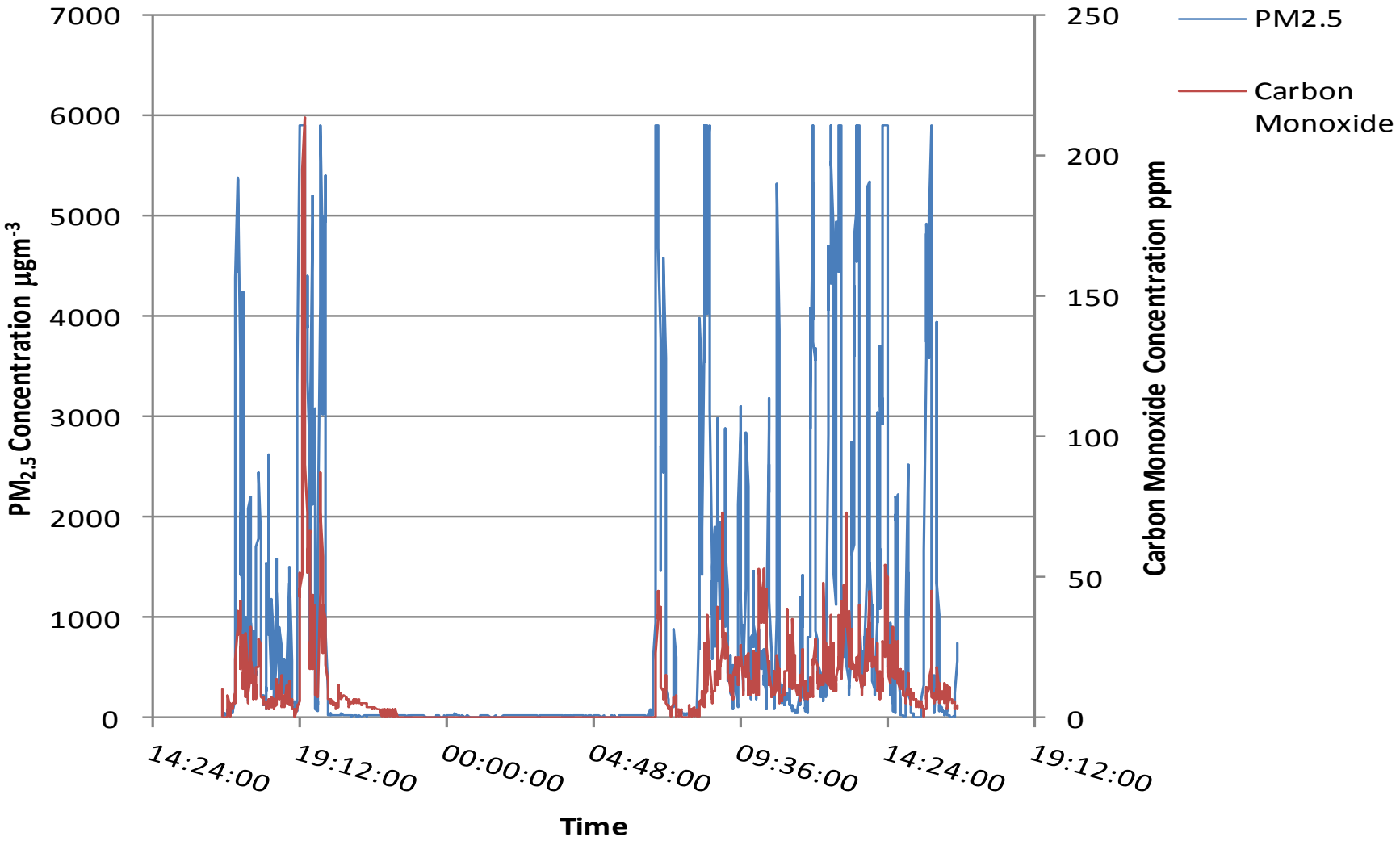
Lascar CO logger

$PM_{2.5}$ and CO levels were measured over 24hours

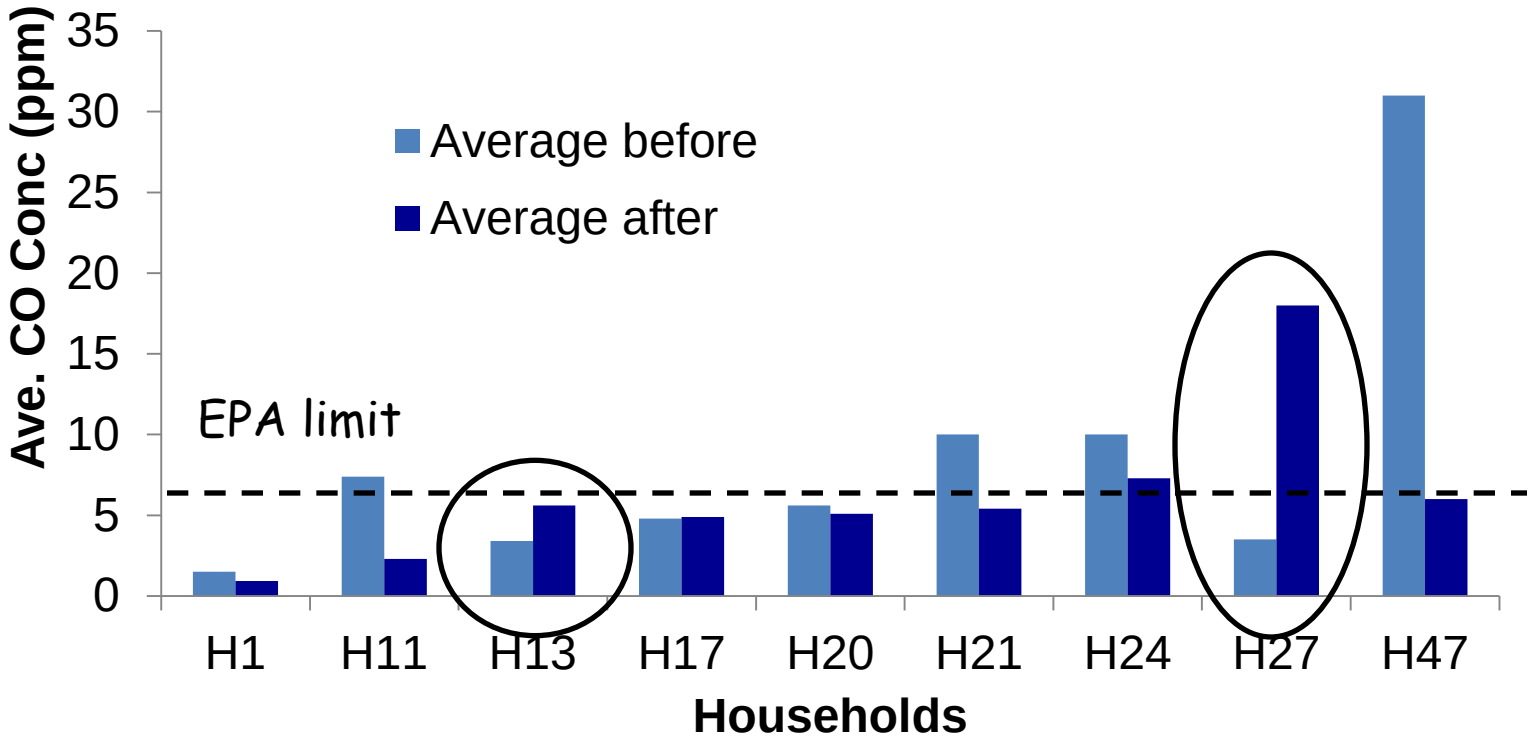
Sampling issues

- Sampling equipment problems
  - Noise
  - Battery life
  - Interference (sources/deliberate)
  - Cost/security
  - Modifications of behaviour
- Personal exposures up to 4 times higher than area/static sampling

Typical household exposure over 24 hours

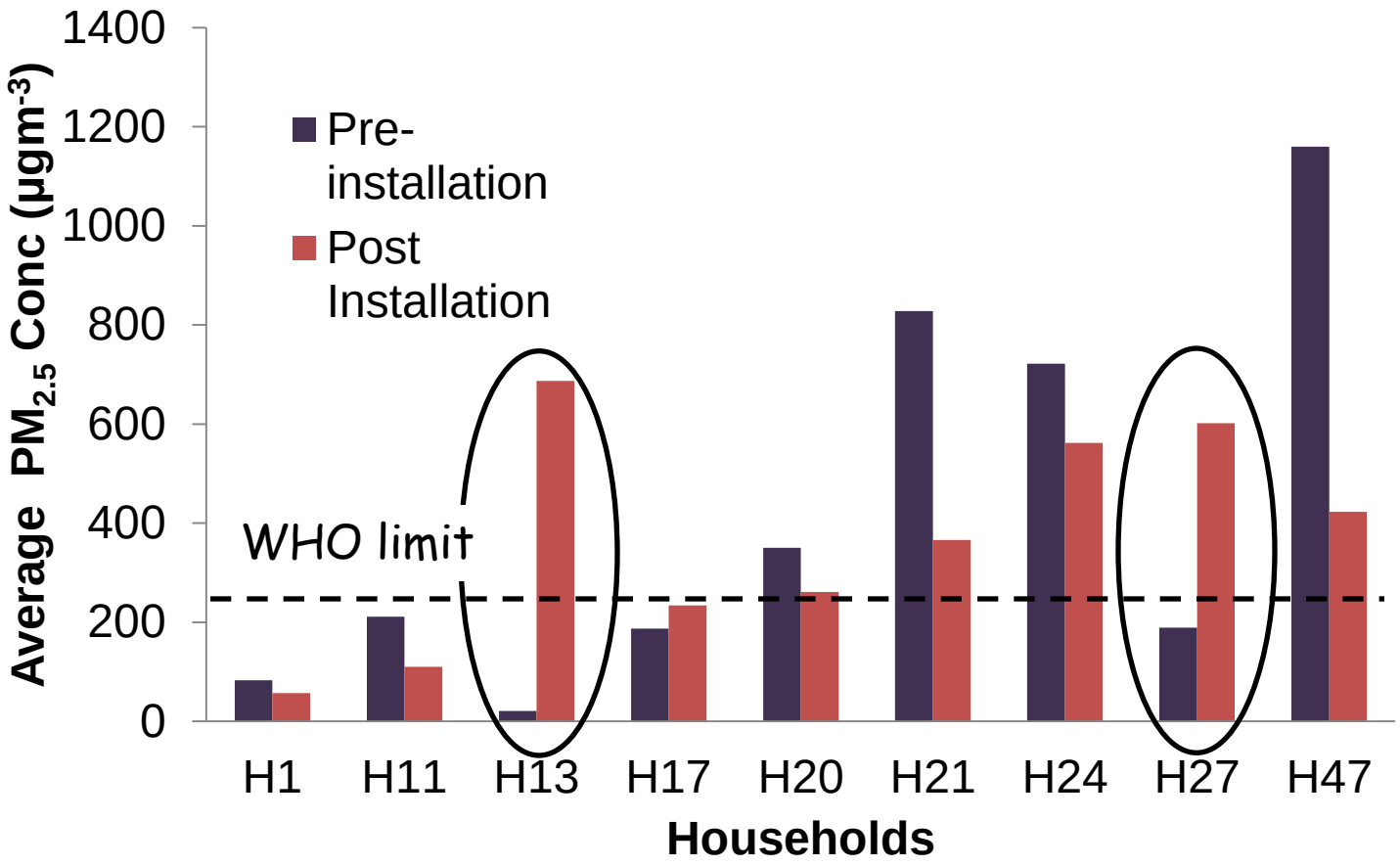


Household exposure to CO (ppm)



	Including All	Excluding H27 & H13
Mean % Change	24%	-25%
Median % Change	-27%	-33%

Household exposure to $PM_{2.5}$



	Including All	Excluding H13 & H27
Mean % Change	352%	-32%
Median % Change	-25%	-31%

Conclusions

- Median reduction in $PM_{2.5}$ and *CO* are 25% and 27% respectively
- Household air quality remains outside safe limits for *CO* (WHO = 6 ppm) and $PM_{2.5}$ (EPA = 250 $\mu g\ m^{-3}$)
- To bring household air quality within safe limits, biogas use should be sufficient to **reduce firewood use to less than 10 kg day^{-1} $household^{-1}$**

Acknowledgements

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