How low does HAP ($PM_{2.5}$) need to be to achieve health benefits?

Recommendations of new WHO guidelines



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Overview of presentation

- Why does this question matter?
- Existing WHO air quality guidelines:
  - A foundation for the new guidelines
- Key questions for the new Guidelines
- Evidence reviewed:
  - Focus on 3 reviews most relevant to our question
- Main recommendations
- Implementation and evaluation plans

- 2.8 billion use solid fuels
- High HAP (>> AQGs)
- 4.3 (2.9, 4.9) million premature deaths (2012)
- World's poorest people; majority rural, facing multiple challenges.
- Experience - sustained use of 'effective' interventions challenging
- Hence ... question of whether moderate ↓ in HAP would → 'useful' health benefit

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Existing WHO air quality guidelines

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

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

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Scope and key questions

Scope:

- Global, with focus on LMIC; all uses - cooking, heating and lighting

4 key questions for guidelines:

- Practical means of assessing performance: what emission rates are required to meet:
  - The annual average AQG and IT-1 for $PM_{2.5}$, and
  - The 24-hr average AQG for CO?
- In light of challenges in securing sustained use of low emission devices/fuels, what approach should be taken during this transition?
- Should coal be used as a household fuel?
- Should kerosene be used as a household fuel?

Additional issues:

- Safety; Health and climate synergies

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Evidence reviews

Evidence reviews

1. Fuel use, emissions and pollution levels:
   - Global patterns of household fuel use
   - Emissions of health-damaging pollutants
   - **Model linking emission rates with air quality**
   - Population levels of household air pollution
2. Health impacts:
   - **Health risks from HAP, including exposure-risk**
   - Specific risks from household use of coal
   - Risks of burns, scalds and poisoning
3. Implementation - interventions and policy:
   - **Impacts of interventions in daily use on $PM_{2.5}$ and CO**
   - Factors enabling and limiting adoption
   - Interventions costs and financing options

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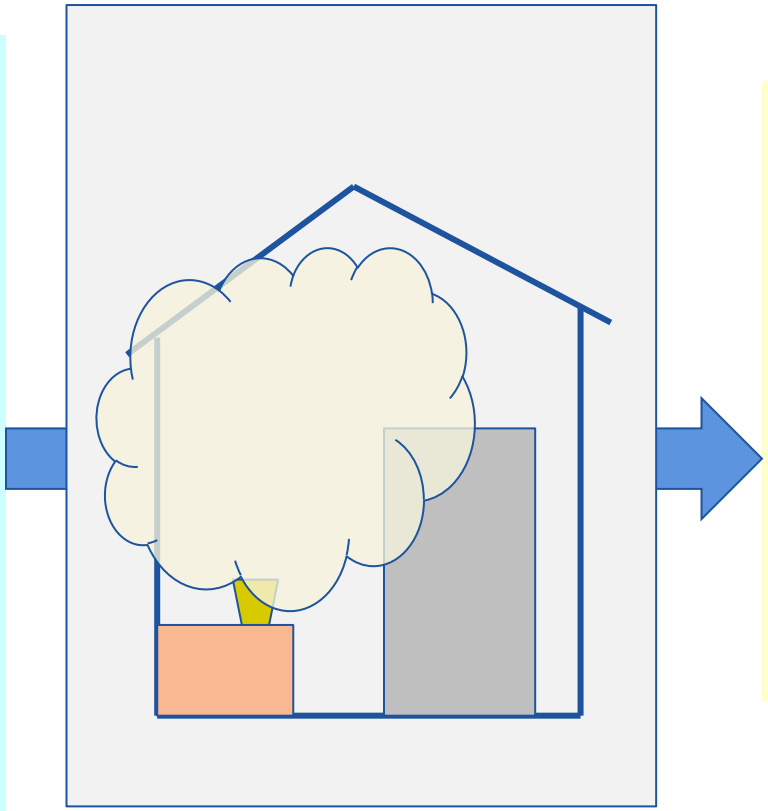
1: Model linking emissions to air quality

Inputs:

- Emission rates:
  - PM2.5
  - CO
- Kitchen volume
- Air exchange rate
- Duration of use (hours per day)



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  - CO

- Uses ranges of inputs and Monte Carlo simulation
- Assumes uniform mixing of pollutants and air in kitchen

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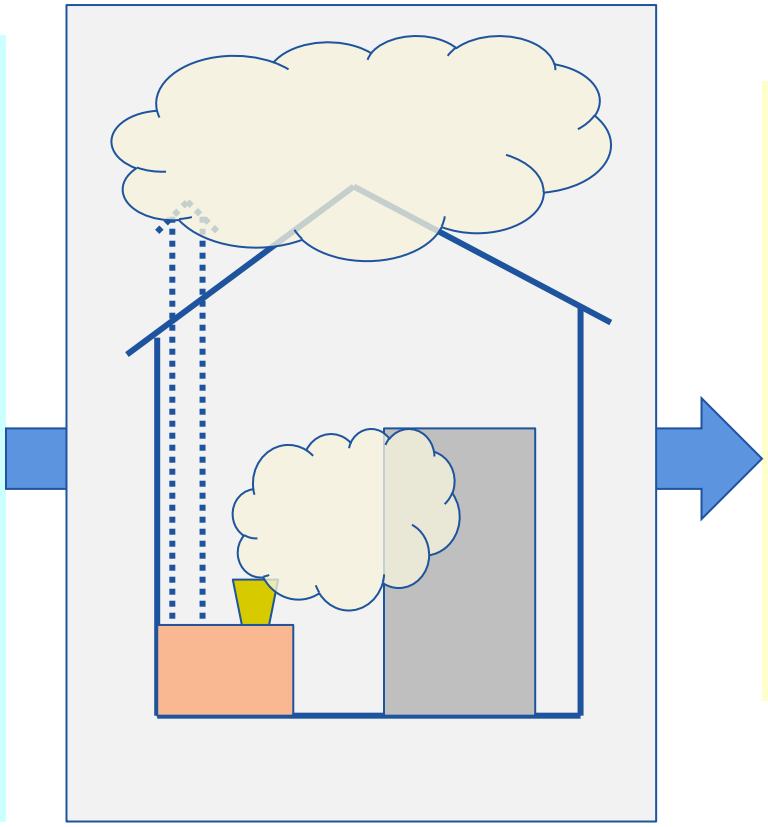

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- Assumes uniform mixing of pollutants and air in kitchen

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2: Health risks from exposure to HAP from solid fuels

Strong evidence	Tentative evidence
• Child pneumonia • Low birth weight • Chronic obstructive pulmonary disease (COPD) • Lung cancer (coal) • Lung cancer (biomass) • Cataract • [Cardiovascular disease]	• Stillbirth • Pre-term birth • Stunting • Cognitive development • Asthma • Other cancers (naso-pharynx, uterine cervix) • Tuberculosis

Also: health risks from kerosene and gas

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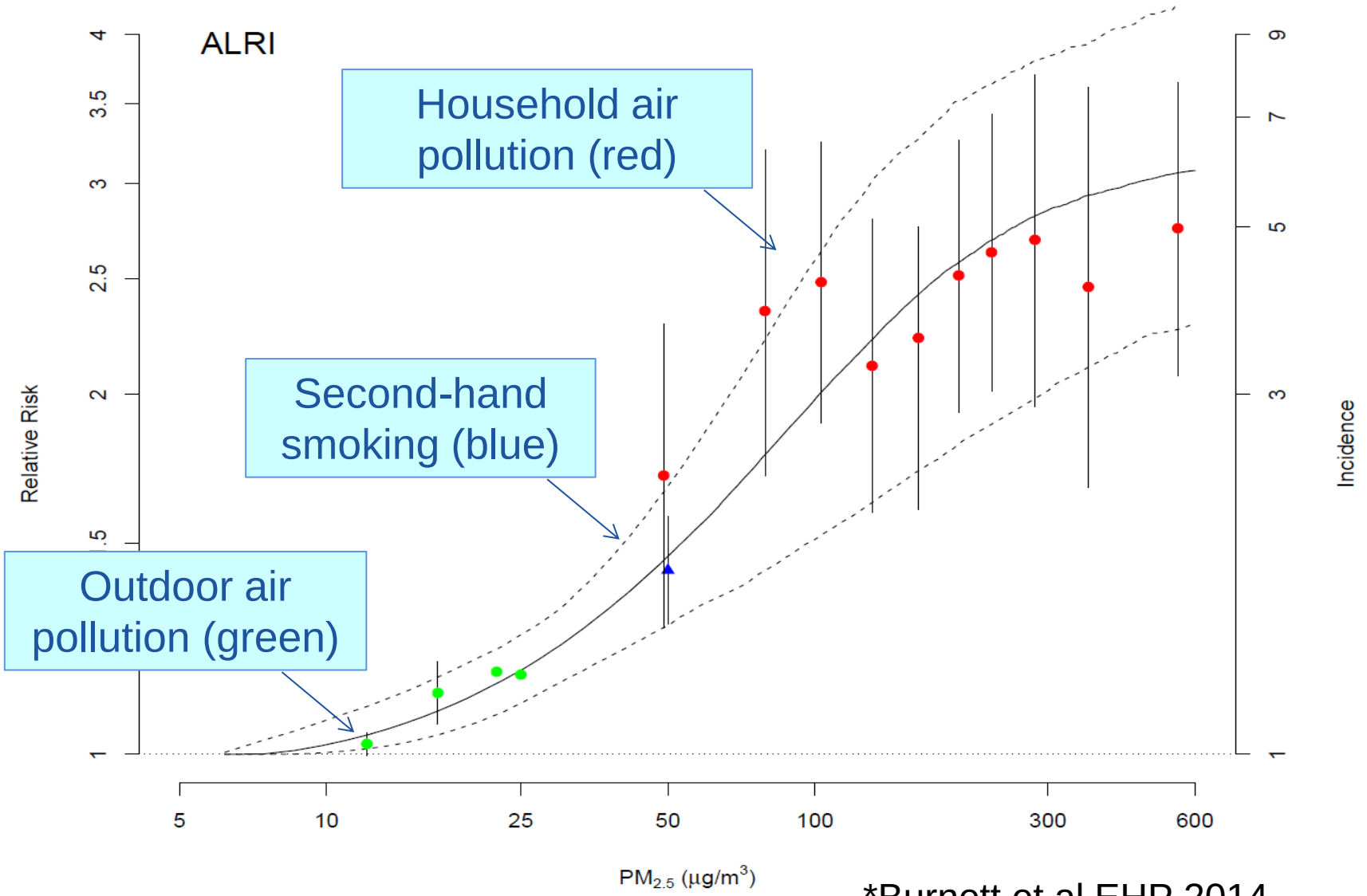
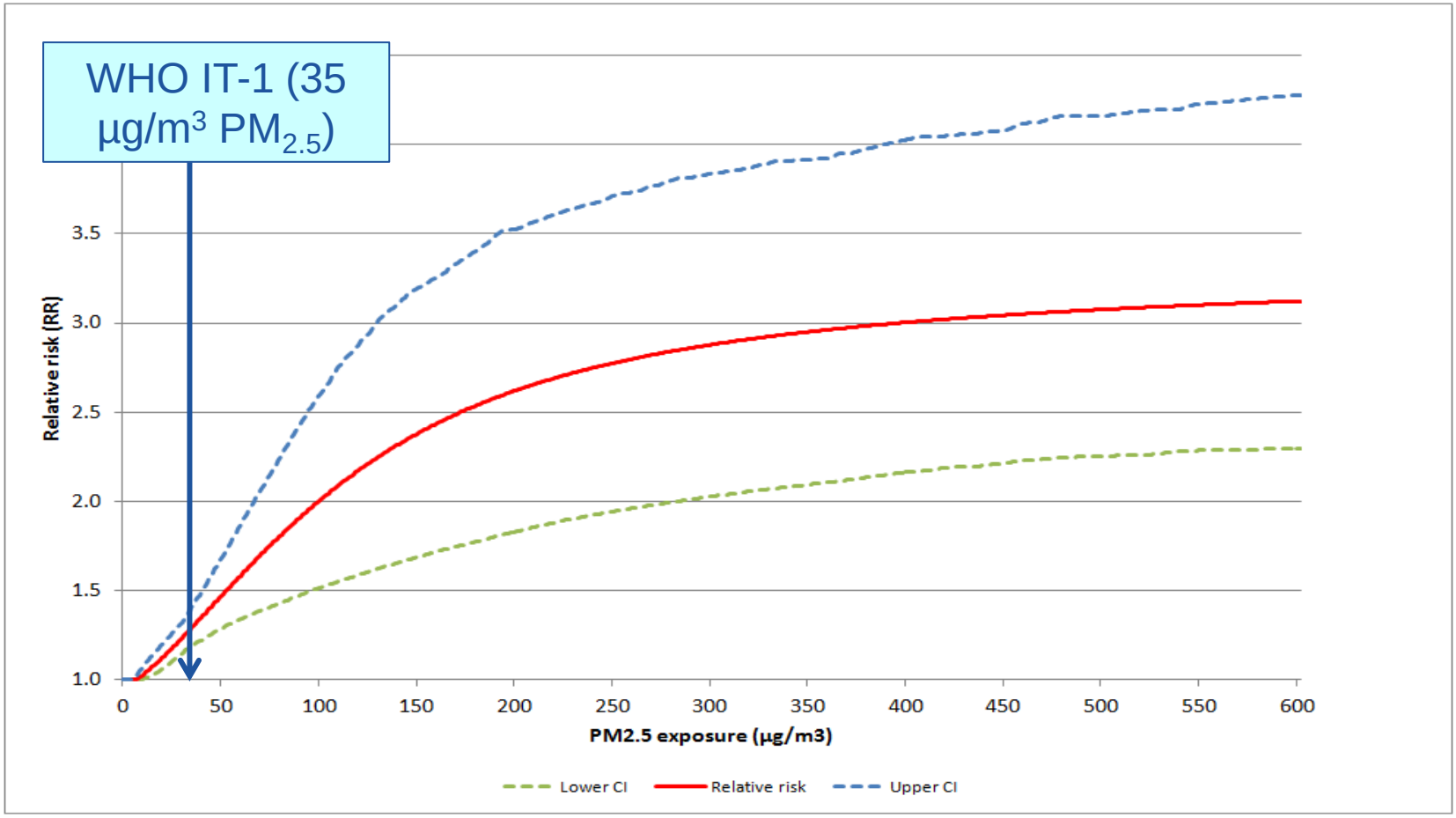
IER function*: $PM_{2.5}$ and child ALRI risk



*Burnett et al EHP 2014

IER function for $PM_{2.5}$ and child ALRI risk (linear scale)



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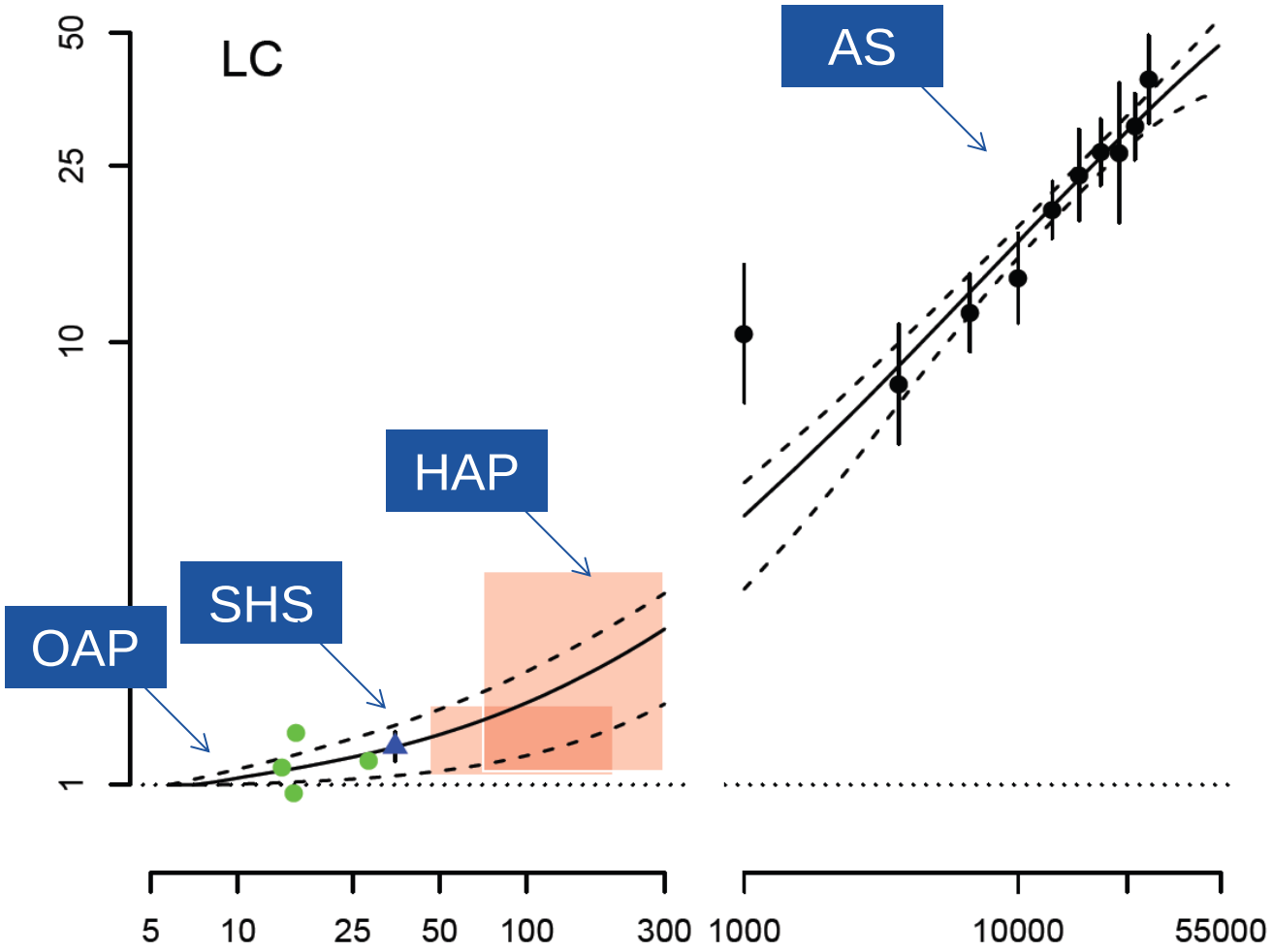
IER functions included

Disease outcome	HAP data available for IER	Exposure measurement
Child acute lower respiratory infection (ALRI)	Yes	Direct
Ischaemic heart disease	No	-
Stroke	No	-
Chronic obstructive pulmonary disease (COPD)	Yes	Estimated
Lung cancer	Yes	Estimated

IER function: lung cancer



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3: Impacts of interventions - daily use ($PM_{2.5}$)

Device and fuel type	Number of studies (estimates)	Kitchen $PM_{2.5}$ ($\mu g/m^3$)		
		Pre-intervention mean	Post-intervention mean	Summary % reduction (95% CI) in mean
Solid fuel unvented	4 (7)	780	410	-48% (-34, -54)
Solid fuel vented	18 (23)	1030	370	-63% (+14, -89)
Advanced solid	1 (3)	650	380	-41% (-29, -50)
Ethanol	4 (4)	720	120	-83% (-63, -94)
Gas	1 (2)	890	280	-64% (-48, -80)
Electricity	1 (1)	160	80	-50% (N/A)

WHO annual AQG = 10 $\mu g/m^3$

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For CO – similar story with important difference that most groups at/below 24-hr AQG

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Recommendations

Focus on emissions reductions – why?

- Indoor ←→ outdoor
- Evidence base stronger than for other approaches
- Implementation practicality – via design, production, standards, etc.
- Some options (clean fuels), are relatively independent of user behaviour.

Rec. 1(a): Emission rate targets ($PM_{2.5}$)

Recommendation

For 90% of homes to meet the WHO AQGs for $PM_{2.5,}$ emission rates should not exceed the emission rate targets (ERTs) set out below.

Emissions rate targets (ERT)	Emission rate (mg/min)	Percentage of kitchens meeting AQG (10 µg/m³)	Percentage of kitchens meeting AQG IT-1 (35 µg/m³)
Unvented			
Intermediate	1.75	9%	60%
Final	0.23	90%	100%
Vented			
Intermediate	7.15	4%	60%
Final	0.80	90%	100%

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Rec. 1(b): Emission rate targets (CO)

Recommendation

For 90% of homes to meet the WHO AQG for CO, emission rates should not exceed the emission rate targets (ERTs) set out below.

Emissions rate targets (ERT)	Emission rate (mg/min)	Percentage of kitchens meeting AQG (7 mg/m^3)
Unvented		
Intermediate	0.35	60%
Final	0.16	90%
Vented		
Intermediate	1.45	60%
Final	0.59	90%

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Recommendation 2: Policy during transition

Recommendation:

- For many, it will take time to meet AQGs (especially $PM_{2.5}$), so intermediate steps (solid fuel stoves) may be required
- Policy should promote clean fuel where and when possible
- Solid fuels: test emissions (ref Recommendation #1), use best possible options
- Monitor use and air pollution (not just laboratory)

- **Rationale:**
  - Health evidence: need low levels for major health benefits (ALRI)
  - In practice, solid fuel stoves not achieving low levels (some vented wood stoves 35-70 $\mu g/m^3$)
  - Even clean fuel users well above IT-1 (other sources)
  - Based on evidence, requires (near) exclusive use of clean fuels to achieve AQG ($PM_{2.5}$).

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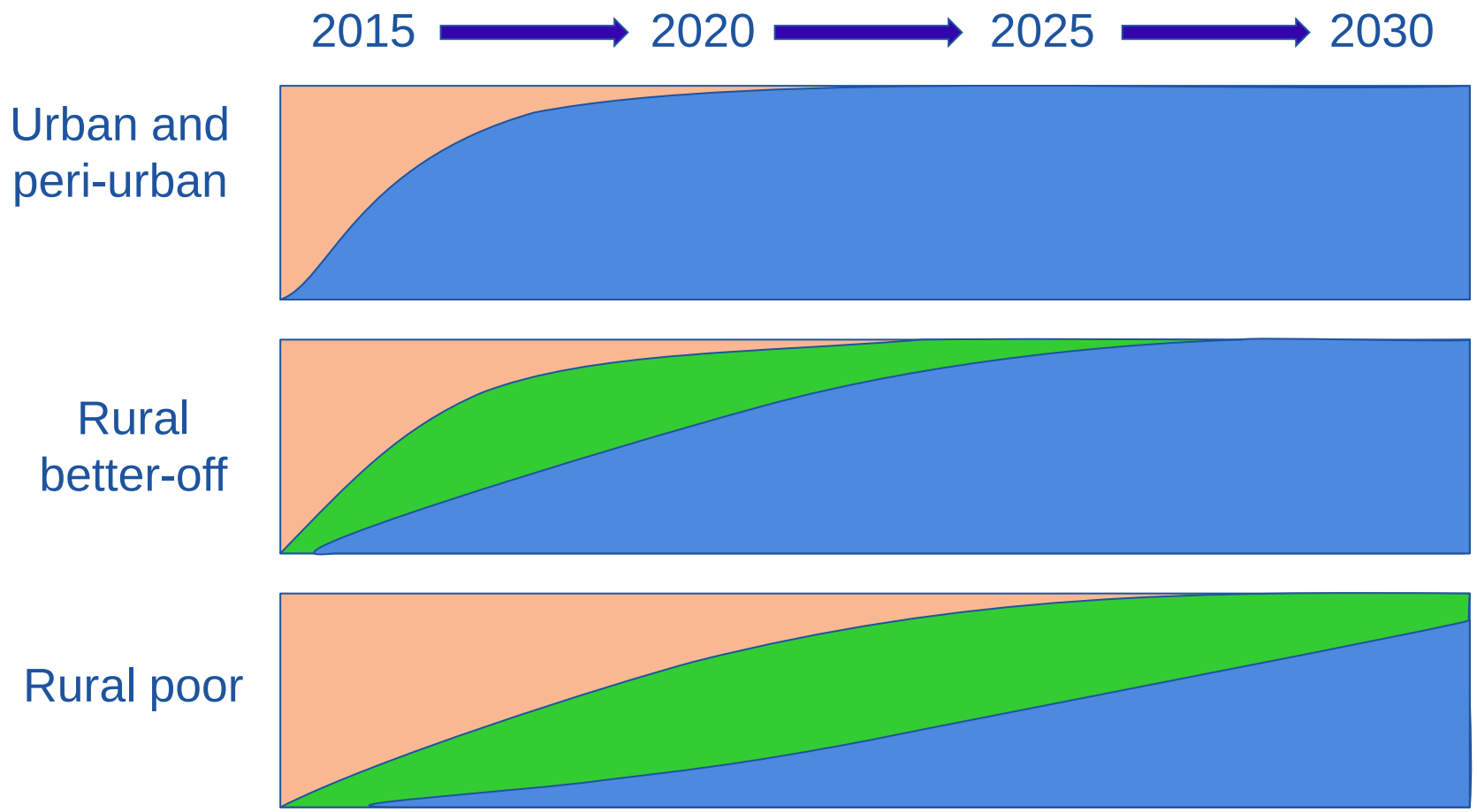
Household energy transition



Traditional biomass

Low emission biomass

Clean fuel

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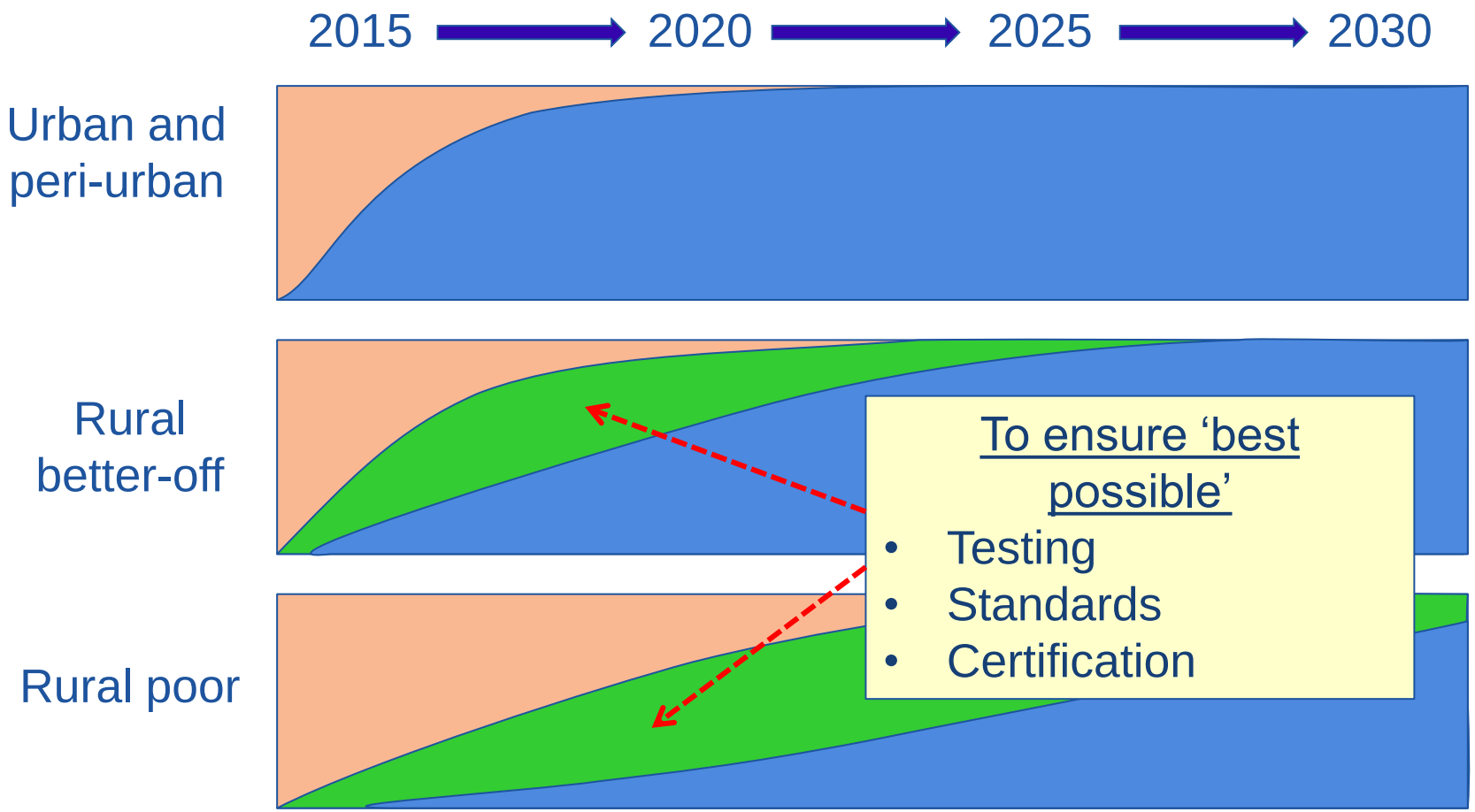
Household energy transition



Traditional biomass

Low emission biomass

Clean fuel

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Rec. 3: Household use of coal

Recommendation:
Unprocessed coal should not be used as a household fuel

- **Rationale:**
  - It is very difficult to burn coal cleanly in home
  - IARC Monograph: emissions from household use of coal are a Group 1 carcinogen
  - Coal often contains toxins (fluorine, arsenic, mercury, etc.) which are not destroyed on combustion.
- There should be further assessment of so-called ‘clean’ and ‘smokeless’ coal

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Rec. 4: Use of kerosene

Recommendation:

Household combustion of kerosene is discouraged while further research into its health impacts is conducted

- **Rationale:**
  - High levels of emissions of PM and other health-damaging emissions.
  - Epidemiologic studies suggest links to cancer, respiratory disease, adverse birth outcomes, etc., but are not of adequate consistency/quality.
  - Kerosene use carries substantial risks of burns and poisoning.

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Implementation and evaluation plans

Outline of implementation strategy

- **IAQ Guidelines:**
  - Outline of strategy in published volume
  - Website: guidance and tools (will evolve)
- **All countries:**
  - WHO region/country offices → Ministries
  - Dissemination through regional workshops
  - Evaluation
- **Work with selected countries and partners:**
  - 4 to 5 countries over 3 years (initially)
  - Defining health sector role; link to policy
  - Arrangements for multi-sectoral working
  - Support development and implementation of action plans
  - Evaluation → revise guidance

Timing	Activity
Mid-2014	Publish IAQG with web pages
2014-15	Regional workshops
2014-17	Work with 4-5 countries
2016	Evaluation of IAQG implementation
2016-17	Revisions to guidance and tools

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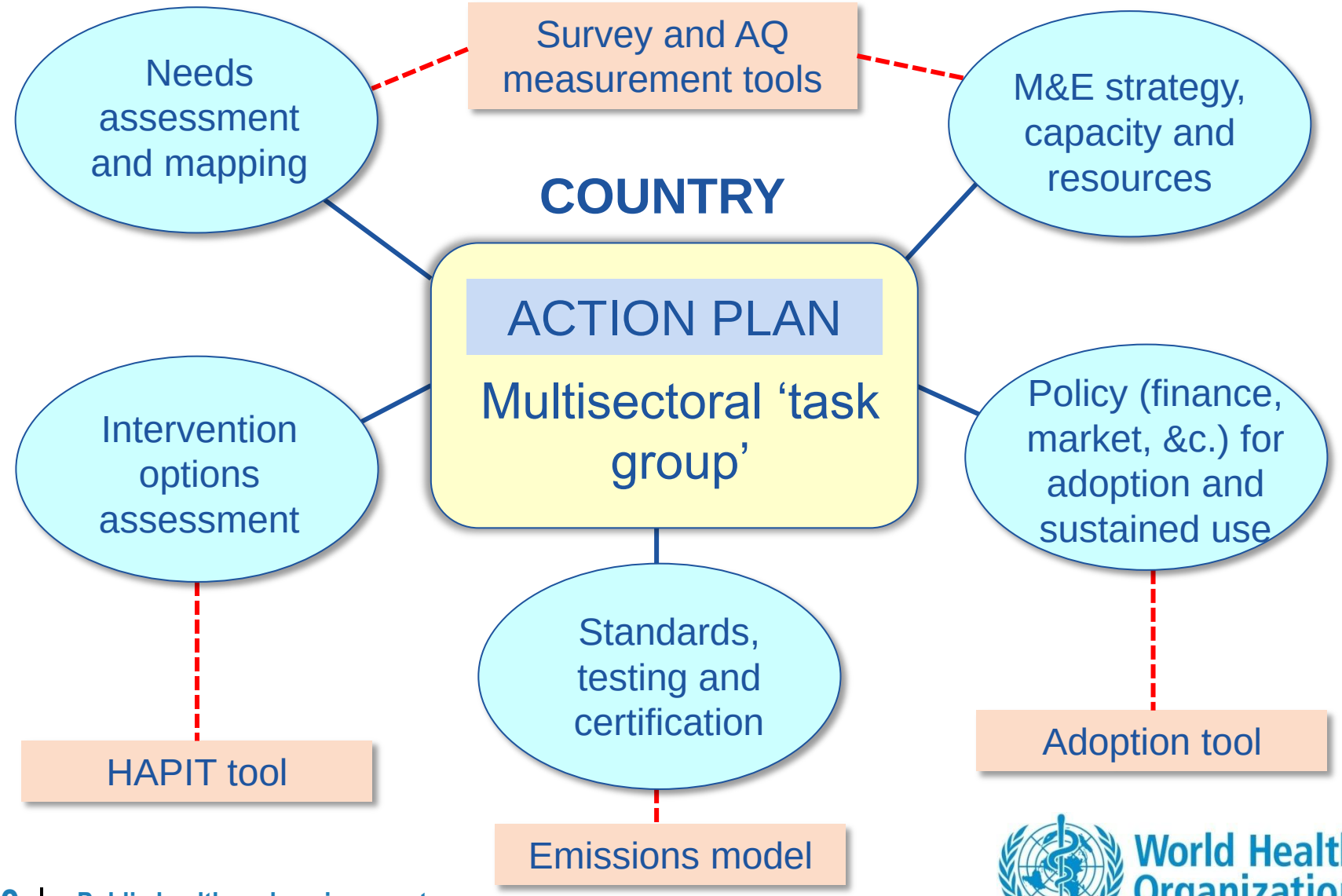
Supporting implementation in countries



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Thanks!

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Additional issues addressed

1. The home does not exist in isolation:
   - Emissions from household combustion contribute outdoor air pollution, some of which re-enters homes
   - Outdoor air pollution from any source (including neighbours' houses) enters homes
2. Household fuel combustion devices/fuels linked to increased risks for burns, scalds, fires, and poisoning
3. Policy for achieving sustained adoption vital if guidelines are to be implemented – especially for poorer, rural homes.
4. Growing evidence on synergies between health and climate impacts

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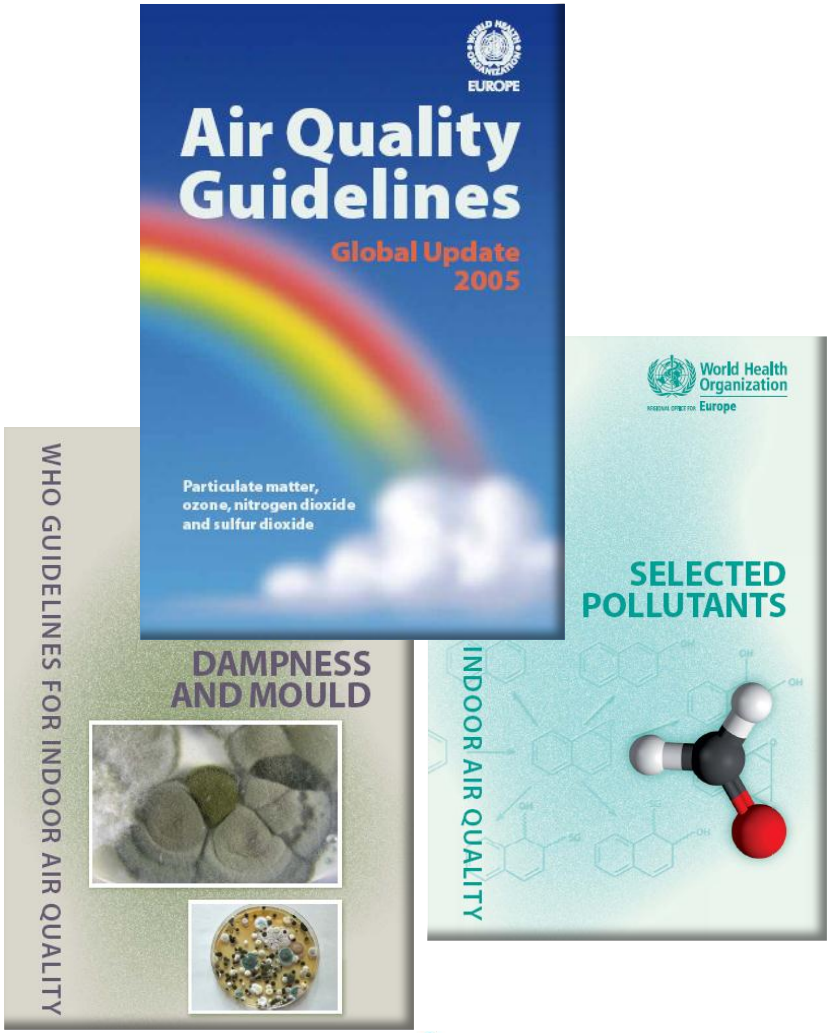
Existing WHO Air Quality Guidelines (AQG)

- Global update (ambient) 2005:
  - $PM_{2.5}$, PM_{10}
  - Chapter on IAP
- Indoor AQG:
  - Dampness and Mould: 2009
  - Selected pollutants: 2010
  - Household fuel combustion: this project



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General considerations

- **Household emissions:** escape and re-enter homes and lower IAQ; so total emissions should be minimised.
- **Local ambient air quality** outdoor emissions (from homes and other sources) affect indoor air quality: implications for community-wide action and control of other sources.
- **Homes have multiple energy needs** (cooking, heating, lighting, etc.): use and emissions from all sources should be considered.
- **Safety:** Safety of interventions for ↓ HAP emissions should not be assumed: approaches to minimize exposure to emissions should be taken in a way that incorporates safety concerns.

Best-practice recommendation

Recommendation:

In view of the close synergy between health and climate impacts of household fuel combustion, climate mitigation policy addressing household energy should include health assessment

- Rationale:
  - Inefficient combustion of biomass (higher emissions) in settings with non-sustainable harvesting contributes to net CO_2 emissions.
  - Incomplete combustion leads to emissions of (shorter-lived) pollutants that are both health damaging and exert positive radiative forcing.

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