Scaling housing interventions for wood-burning stoves worldwide

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SCALING HOUSE INTERVENTIONS FOR WOOD-BURNING STOVES WORLDWIDE

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FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA
Domestic biomass combustion worldwide

We know that biomass burning can be carbon neutral when using dry local biomass performing lightning from top to down and operating the stove with primary and secondary air to burn volatile organic compounds.

A global issue...

- Human health
  - Epidemiological studies
  - Associated to human exposure to air pollutants

- Health of the globe
  - Desforestation
  - Energy consumption
  - Air pollution/ climate change
Causes of inefficient biomass combustion (large increase on solid-fuel burning during the last years)

- **Impacts on human health**, there is a global issue of **climate change**
- **Indoor confort**
- **Air pollution due to inadequate operation**
- **Low quality solid-fuels**
- **Impacting on biodiversity**

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Ricardo L. T. Carvalho

Air Pollution & Climate Secretariat, 2013
Appropriate domestic biomass use: What are the potential measures for GHGs mitigation?

1. Design new cleaner combustion appliances
2. Zero emission of unburned gases and black carbon
3. Sophisticated ecodesign/confort
4. Efficient practices
5. Low cost innovations
6. Collect residual dry wood and use of modern fuels
Practices and solid fuels worldwide

Developing regions:
- Cooking
- Lightning
  - Firewood, straw, briquettes, shrubs

Developed regions:
- Cooking, space heating/DWH
- Heating/cozyness
  - Charcoal, waste, briquettes, pellets, biogas, LPG
  - Firewood, pellets, natural gas, electricity

Income levels:
- Low income (Asia, Africa, Latin America)
- Middle income (Europe, Latin America and Australia/NZ)
- High income (Northern Europe, US and Canada)
# Overheating in low energy houses

*new biomass stoves and EU labelling*

Heating requirement (kW) for a sitting room at 50 m²

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<td>3,0</td>
</tr>
</tbody>
</table>

*Ole M. Jensen et al. Danish Building Research Institute, 2012*
Global mitigation of air pollution focusing on (ultra) fine particles and carbon By improving thermal efficiency

Magnitude of interventions in dwellings?

- Billions of people
- Millions
- Thousands

Developed Regions
- Well developed regions
- Mid income
- Developed

Developing regions
- High -x-
- Levels of complexity...-x-
- Low

η>50
η>80%
η>85%

Appropriate lightning chamber, with PCMs clean chimneys
Digital control and heat storage
Secondary air intake/outdoor primary air

Modern fuels
- High income
- Mid income
- Low income

4500 - 6000 €
400 - 4500 €
100 - 400 €

Improved local solid fuels

4500 - 6000 €
400 - 4500 €
100 - 400 €
Indoor climate measurements in low energy houses

guidance to scaling household interventions

Operating manually

Energy savings
Fine particle mitigation

Lightning stove

Afshari, A. et al., 2011
Testing efficient cooking stoves (Latin America)

Improved cooking stove Nina (Peru) have a thermal efficiency of 30% and new efficient wood cooking stove IDER (Brazil) saves 40% of solid-fuels.
Cataloging stoves in Latin America and Europe
Methodology for modelling mitigation measures impact

Number of users for regions, stoves and solid fuels

- Thermal mass/storage (appropriation and energy savings)
- Household’s real heating demand
- Stove heating supply (matching)
- Biomass consumption per hour
- Calorific power capacity/wet fraction of biomass

Reference Scenario 2010

- Best practices
  - High
  - Mid income
  - Low

Emission factors

- PM2.5
- CO
- TVOCs

Domestic Biomass use 2030

Appropriate heat demand
Increasing $\eta$

Potential savings/mitigation

PM2.5 emissions 2030 (g/kg)
Modelling/estimations energy savings and PM$_{2.5}$ emissions EU27 (work in progress…)

Scenario A: stable

- PM$_{2.5}$ emissions (tonnes)
- CO emissions (tonnes)
- Biomass use (tonnes)
Modelling/estimations energy savings and PM$_{2.5}$ emissions in Latin America *(work in progress…)*??
Scale up-grading biomass stoves until 2030
big changes with low cost innovations?

Innovations (degree of complexity)

Green: Developed regions
Orange: Developing regions

- primary air in small chamber
- p-secondary air automation
- p-s-terciary outdoor air automation using modern fuels
- automatic heat exchange
- solar/automatic heat exchange with filters
- solar/automatic exhaust with filters

Years:
- 2010
- 2015
- 2020
- 2030

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QUESTIONS?

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