Indoor air pollution caused by wood-burning in Brazilian and Danish dwellings

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INDOOR AIR POLLUTION CAUSED BY WOOD-BURNING IN BRAZILIAN AND DANISH HOUSEHOLDS

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Domestic wood combustion worldwide
low-cost stoves in low carbon dwellings

Biomass burning can be carbon neutral when performed under optimal lightning and operating conditions

Many different practices by more than 3 billion people worldwide representing one of the major causes of respiratory diseases such as asma and allergies with more than 4 million premature deaths each year, in both developing and developing countries (UNDP, 2011)

Human health
Epidemological studies
Associated to human exposure to air pollutants

Sustainability of the globe
• Desforestation
• Energy consumption
• Air pollution
Inefficient residential biomass combustion

Air pollution

Deforestation

Overheating

Indoor air pollution

Respiratory diseases such as pneumonia by inhalation of fine particles and carbon monoxide as well as high indoor temperatures

Air Pollution & Climate Secretariat, 2013
Appropriate domestic biomass use:
What is the potential for the mitigation of GHG emissions?

Contribution for a cozy atmosphere in low energy houses

Zero carbon emissions

Sophisticated design

Resilient use of residual biomass

Low tech

Low cost modern fuels

What is the potential/magnitude of the mitigation measures by implementing certain practices including technological innovations and modern fuels in biomass stoves?
Indoor wood smoke in developing regions

- **Latin America, África and Asia are among the developing regions where domestic wood combustion is very popular (3 billion people worldwide)**
- **In Brazil** around 27.2% of the residential energy consumption is associated to the use of wood logs for cooking/heating (cold regions) (BEN, 2013)
- Ineficient domestion biomass burning practices causes overheating and indoor contamination by unburned gases associated to the uncompleted wood combustion in rural housing of northeast Brazil

New efficient combustion chambers have been being developed worldwide in order to optimize the complete biomass combustion towards the reduction of black carbon emissions indoors and outdoors
Wood heating as a resilient practice towards a cozy atmosphere?
Large-scale wood-burning stove program in CE-Brasil/Latin America
Indoor climate in rural households (Brazil)
...when using an improved efficient mass stove?

Mean outdoor temperature 33-35 °C and RH 40-51%
Fine particles in rural households (Brazil)
kitchens of developing regions in northeast Brazil

- House B with a lower ventilation rate in a closed kitchen with no wind brise reaveled an higher indoor concentration of fine particles.
- The stove chaminey exhaust at the house A presented was not working properly due to lacks of cleaning, inadequate installations and the stove walls were leaking the flue gas due to breaks on the brick walls caused by very high temperatures in the brick walls.
- Soft wood promotes indoor smoke and a short-term combustion.

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Concentration of PM2.5 (µg m⁻³) / BR

**House A**
**House B**
**House C**
**House D**
**House E**

Ignition

time (min.)

00:01 00:06 00:11 00:16 00:21 00:26 00:31 00:36 00:41 00:46 00:51 00:56 01:01 01:06 01:11 01:16 01:21

0 1000 2000 3000 4000 5000 6000
Field studies in single-family households in CPH (Denmark)

R. L. T. Carvalho, 2013
Indoor climate in a low energy house (Denmark)
...using a certified wood cast-iron stove...
Indoor climate in a Danish single family house (class B)

...using a wood mansory stove...
Inhalable particles in low energy households (Denmark)

- House B and C with a lower ventilation rate and higher air-tightness using Swan labelled cast-iron stoves, respectively, reaveled indoor concentrations of PM$_{10}$ over 150 µg m$^{-3}$ during periods larger than 1 hour (air-exchange rate $33-58$ m$^3$h$^{-1}$)
- Hard wood promotes a long-term combustion for more than 1 hour/cycle
- Even the expert in lightning was not able to mitigate high emission of inhalable particles in class A single-family houses
Conclusions
findings
worldwide
THANK YOU FOR YOUR ATTENTION

QUESTIONS?

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