Stoves 101

An introduction to improved biomass cookstoves

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Programme for Poverty oriented basic energy services

ETHOS, 28th January 2012 Kirkland Northwest University
 „...When I get up in the morning the first thing is to make fire...“

How about you?

What energy sources do you use?

Why?

What types of 'stoves' do you have at home?
• We ALL need food to live
• Most food needs to be cooked
• For cooking we need energy (fuel)
• Cooking energy accounts for >90% of household energy in developing countries
• Over 2.5 billion people use solid biomass fuels (firewood, charcoal, dung, agricultural residues)
• Firewood and charcoal are often from non-renewable sources and getting scarce
• In conventional fires they often cause harmful emissions
common scenarios

• wasteful
• dangerous
• smoky
How does fire burn?

Where is the hottest part of a flame?

What other conditions influence the performance of a fire?
What happens when biomass is burnt?

Solid state fuel

Gaseous state fuel

Emmissions

Water vapour

Smoke

'Wood'-gas

CO2

Water vapour

Heat

Combustion Gas-Air-Mix

sufficient O2

Dry Bio-mass

Pyrolysis Carbonisation

Bio-Char

Char gasification

Ash

Raw Bio-mass

drying

Heat

O2 from air

necessary inputs for transformation

Legend: solid Gas Transformation Input Output

Design: Christa Roth
All processes occur simultaneously in an uncontrolled manner

- Raw Biomass → Dry Biomass → Pyrolysis Carbonisation → Bio-Char → Char Gasification → Ash
- Water vapour
- CO₂
- ‘Wood’-gas
- Heat
- Smoke

Legend: solid, Gas, Transformation, Input, Output

necessary inputs for transformation → Heat → O₂ from air

Emissions Gaseous state fuel Solid state fuel

Design: Christa Roth
What can we do to make this fire safer for the users and their children?
contain and shelter the fire from wind
How can we save energy?

• Using improved stoves and fireless cookers - *technologies*

• Keeping a lid on the pot, soaking legumes, using less water, cooking for less time etc. - *techniques*

How can we get more firewood?

• Cut the branch and not the tree
• Plant trees or just let them grow
• Plant woody shrubs e.g. pigeon peas that provide both food and fuel
What do we call a 'stove'? 

'stove' = combination of 

Heat-Generator + 

Heat-Transfer- structure 

Form of a 'stove' depending on fuel and cultural factors e.g. cooking task (type of meal), type of cooking (one-handed or two-armed-full-upper-body-motion needed), pot-shape and size etc.
Benefits of energy saving technologies

- Mud stove
  - With clay liner
- Clay stove
- Food warmer
  - or fireless cooker
- Rocket Stove

- Saving up to 80% firewood
- Small twigs can generate enough heat for cooking
- Smoke reduction
- Fast cooking, less time
- Sheltered fire, less heat exposure

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Rocket stove principle

- improved combustion: burn the smoke and get more heat from fuel
- improved heat-transfer: more cooking from heat
A range of cookstoves to suit different needs and means

1 USD  8 USD  15 USD  20 USD  30 USD
50 USD  80 USD  50-100 USD  200 USD  300 USD
Institutional Rocket stoves

with open fire

170 kg

with Rocket stove

14 kg
School feeding programme Mary’s Meals Blantyre

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How to get stoves out there: Implementation approaches

<table>
<thead>
<tr>
<th>Rural Low-income Households</th>
<th>Urban Low-income Households</th>
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<tr>
<td>portable clay stove</td>
<td>fixed mud-stove</td>
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<td>Social marketing by</td>
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<td>implementing partners</td>
<td>suitable strategy</td>
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<td>i.e. for ‘food&amp;fuel’</td>
<td>Local product too</td>
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<td></td>
<td>expensive, imports</td>
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<td></td>
<td>competitive</td>
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Implementation approaches

**Smallholder contract farmers**
- Portable clay stove
- Social marketing by contractor to encourage fuel-saving

**Staff in company housing**
- Fixed (insulated) ‘Changu’ stove
- Promotion by Agro-industry, refinancing through produce e.g. Tea, Tobacco, Sugar
- Fixed (solid) ‘Esperanza’ stove
- Corporate Social Responsibility: company builds stoves in staff houses as CSR activities

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New focus on emissions:

- WHO waking up to the fact that every year over 1.5 Mio people, mainly women and children, die from diseases attributed to or aggravated by exposure to smoke. 'Smoke' claims more victims than breast cancer or malaria!
- Global Alliance for Clean Cookstoves by the UN Foundation tries to address the problem by promotion of 'clean' cookstoves, that reduce emissions by 90% and save 50% of the fuel compared to an open fire. Their ambitious aim is to disseminate 100 Mio clean cookstoves by 2020.
When do we get smoke?

Mainly from solid biomass fuels:
Emissions = $\text{CO}_2$, $\text{H}_2\text{O}$, but also CO and PM

Wood => 'smoke' (perceivable)

charcoal => CO (not perceivable)
Smoke = incomplete combustion

even 'improved stoves‘ can smoke!

Factors:
- fuelwood (too big, too wet,..)
- Air (not enough, too cold,...)
- Temperature (too cold...)
- User / human factor

...so do we have solutions for 'clean‘ stoves?
Biomass gasification: Gas-generation controllably separated in space and time from gas-combustion

Legend: solid Transformation Input Gas Output Design: Christa Roth
Gasifier - the new concept

Separate control of Generation and combustion of gas from biomass with very simple means.

Air-controlled instead of fuel-controlled

Gasifier: Batch-feeding of fuel, heat controlled by air regulation

conventional fires: constant feeding of fuel, unregulated air-supply
Gasifiers - an option for a quantum leap towards emission reduction

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Basic Design principle of a pyrolytic TLUD gasifier

A single tin with separate entry holes for primary and secondary air as combustion unit. Thorough mixing of gaseous fuel and oxygen to ensure optimal combustion can be enhanced with a concentrator disk. A riser can increase draft and air flow.

Combustion:
Visible flame + usable Heat
Mixing zone of rising hot gases with secondary air
Initiate pyrolysis by lighting top of fuel bed with a fire starter material
Self-sustaining flaming pyrolysis front progresses downward through the bed of raw solid fuel, leaving behind char above
Primary air enters at the bottom of the fuel bed and moves upwards

Design: Christa Roth
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Gasifier for cooking
depending on cooking task at hand

- application lower than < 75 cm
- Flame on top (no gas-conduct)

remember:

stove = combination of Heat-Generator + Heat-Transfer-structure
Advantages of gasifiers compared to...

... conventional wood-fire:
  • **complete combustion** (clean burning, less smoke, more useful thermal energy)
  • **flexible use of a multitude of small-size renewable residues** (e.g. rice husks, nutshells, saw-dust etc.), no timber-based stick-wood or charcoal

... Biogas:
  • Creation of gas from **dry biomass** with very simple inexpensive technology directly in the burner unit *(portable, no piping or special burner-head needed)*
  • performance similar to biogas or LPG (but independent from water or digester)

... Solar cookers:
  • cooking energy available on demand (independent from clear weather or daylight hours)

... fossil Gas and Electricity:
  • generate their own gas independent from imports or national providers
  • fuel can be collected or purchased at little cost and at own convenience
GIZ-HERA Manual
Micro-gasification: cooking on gas from biomass

1) ‘Wood-gas’ from biomass and its application for cooking
2) Technologies and applications of micro-gasification to cookstoves
3) Feedstocks and fuels for micro-gasification

More information on Energypedia and the GIZ-HERA cooking energy compendium
Chapter from GIZ-HERA cooking energy compendium on

Recommendations on Cooking Energy Technologies and Practices

Cooking with wood-fuels (firewood + charcoal)
- Cooking with firewood
  - firewood stove types for households, SMEs, and social institutions
- Cooking with charcoal
  - charcoal stove types
- Efficient cooking practices for wood-fuel users
- Testing of wood-fuel stoves

Cooking with other biomass fuels
- Cooking with solid non-timber biomass
  - unprocessed residues
  - processed fuels (e.g., briquettes, pellets)

Cooking with liquid biomass fuels
- methanol, ethanol
- plant oil

Cooking with gas from biomass
- biogas: raw methane + end stress
- woodgas: pyrolysis of dry biomass

Cooking with the sun
- solar cookers

Cooking with fossil fuels
- kerosene
- fossil gas
- coal

General Cooking Practices
- Kitchen management
  - General practices (incl. ventilation)
  - Use of devices like pressure cookers or fastless cookers

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Thank you,

Please feel free to ask MANY questions