

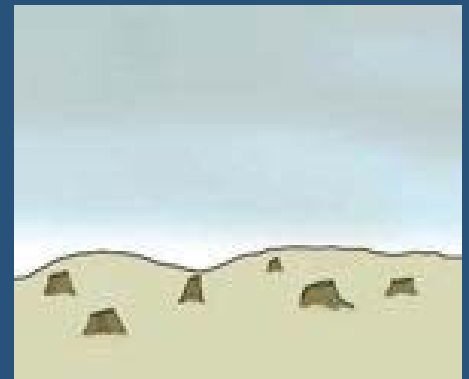
State of Improved Cook stoves



Cooking Around the World



- More than half of the world's population—three billion people—cook their food and heat their homes by burning coal and biomass over open fires or rudimentary stoves.
- Indoor burning of solid fuels releases: particulate matter, carbon monoxide, and other toxic pollutants; leads to indoor air pollution levels that are 20 to 100 times greater than WHO air quality guidelines; and releases greenhouse gases into the air.
- Can lead to deforestation with inefficient use of fuel.
- Women and children spend more time collecting firewood than they do working, studying, etc.





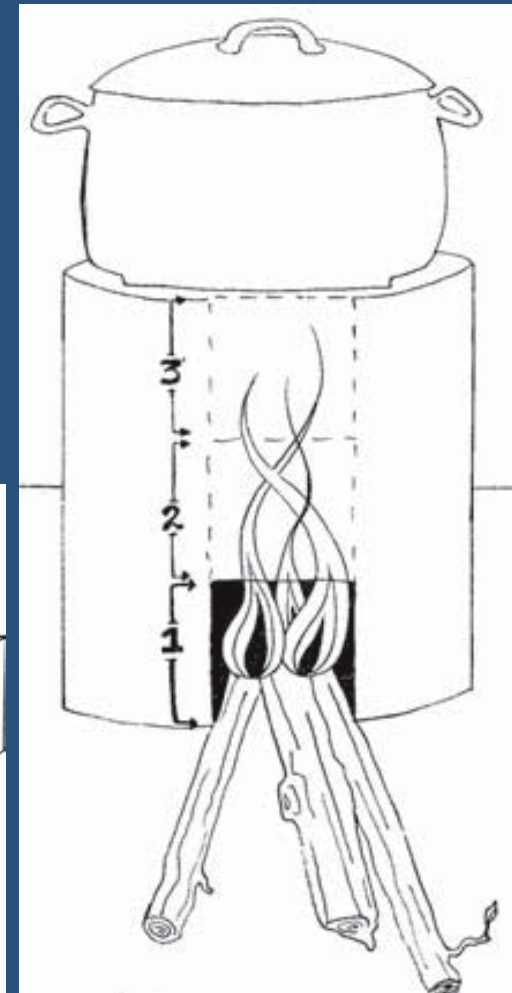
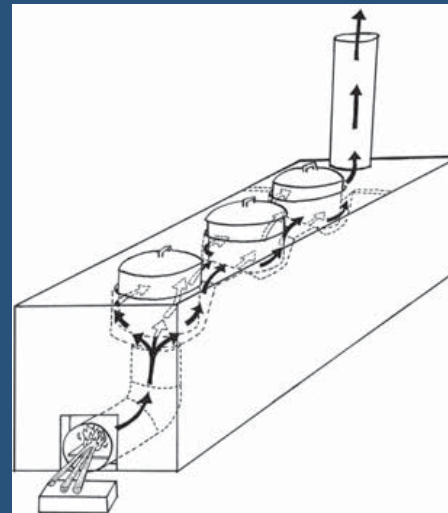
“Improved” Cookstoves

- Improved stoves can (and should) use less fuel (up to 60%), produce less soot, burn hotter (and therefore cleaner) to produce less emissions, decrease cooking times, funnel emissions out of the cooking space, and should be safer.
- Not all stoves are more efficient—some heat up too much and use more fuel, some can emit more emissions than an open fire (if they burn at too low a temperature they can be smokier)
- Not all stoves are culturally appropriate or safe for all uses and may be too expensive, of materials that aren't locally available, get too hot externally (dangerous), or make food taste “bad”.

Stove Designs: Rocket Type



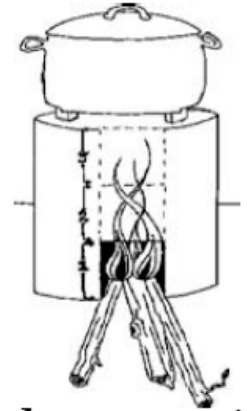
- Many different experiments through time; common stoves are either stand alone (and moveable) or built in place
- Feed can be batch fed or intermittent feed and some stoves also can use a fan to keep fire hot and reduce soot
- Rocket stove is common intermittent feed—all stoves of this design combine air intake with fuel feed to combustion chamber and a chimney (chimney may be leading to fire).



TEN DESIGN PRINCIPLES FOR WOOD BURNING STOVES



Aprovecho Research Center
Advanced Studies in Appropriate Technology



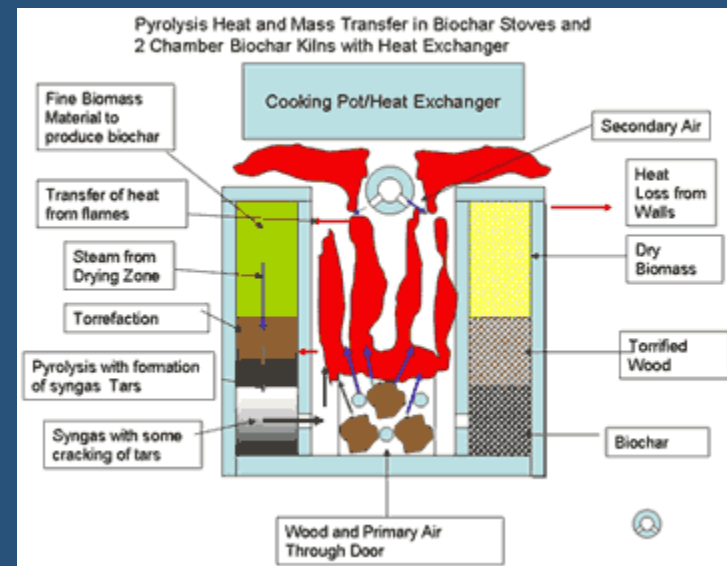
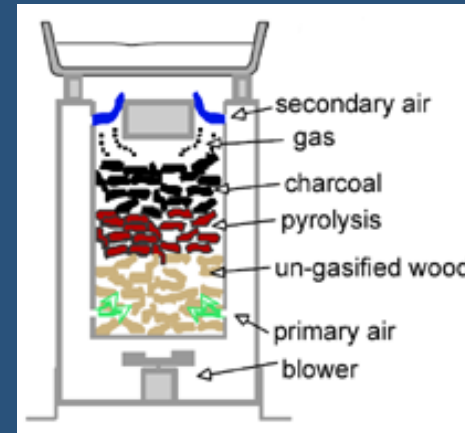
By Dr. Larry Winiarski

- 1** *Insulate around the fire* using lightweight, heat-resistant materials.
- 2** Place an insulated short *chimney right above the fire* to burn up the smoke and speed up the draft.
- 3** Heat and burn the *tips of the sticks* as they enter the fire to make flame, not smoke.
- 4** High and low heat are created by *how many sticks* are pushed into the fire.

- 5** Maintain a **good fast draft from under the fire**, up through the coals. Avoid allowing too much extra air in above the fire to cool it.
- 6** **Too little draft** being pulled into the fire **will result in smoke and excess charcoal**.
- 7** **Keep unrestricted airflow** by maintaining constant cross sectional area through the stove. The opening into the fire, the size of the spaces within the stove through which hot air flows, and the chimney should all be about the same size.
- 8** Use a **grate** under the fire.
- 9** **Insulate the heat flow path**, from the fire, to and around the pot(s) or griddle.
- 10** Maximize heat transfer to the pot with **properly sized gaps**.

Other types of stoves

- TLUD (top-lit updraft gasifier) stove using natural draft that leaves a charcoal residue after cooking is done (can produce biochar to put in soil); commonly batch feed.
- Anila—gasifier stove which produces biochar and hot flame





Energy Value of Various Fuels

Description	Heating Value (MJ/kg)
Wet Firewood (60% moisture content)	8
Cow Dung	10
Tree Residues (twigs, leaves, etc.)	13
Agricultural Residues (straw, cotton stalks, etc.)	13
Air Dried Firewood (20% moisture content)	15
Densified Briquettes (wheat straw, rice husks, bagasse)	16
Oven Dried Firewood (10% moisture content)	20
Peat	21
Charcoal	28
Charcoaled Briquettes	30
Kerosene	44
Biogas	45
Liquid Propane Gas	46

Emissions



- Main emissions are Carbon monoxide, hydrocarbons, and fine particles
- A great deal of black carbon comes from cook stoves (also forest fires and industry). Unfortunately, even some improved cook stoves that are otherwise efficient users of wood still emit large amounts of black carbon. Gasifier stoves will have lower emissions than a rocket stove, but the best way is a fan with secondary air above the flaming zone to burn the smoke.



Stove Testing

- Per Partnership for Clean Indoor Air and APROVECHO Guidelines:
 - Water Boiling Test (how fast and how much fuel used)
 - Controlled Cooking Test (specific parameters in “ideal” situation)
 - Kitchen Performance Test (how performs in everyday uses)
- Zamorano Tests using all above methods as well as measuring emissions

Partnership for Clean Indoor Air



- One of the largest groups which has more than 170 public and private organizations working in 70 countries have joined the Partnership for Clean Indoor Air.
- The Partnership focuses on four priority areas which have proved to be essential elements for sustainable household energy and health programs in developing countries:
 - Meeting Social and Behavioral Needs
 - Developing Local Markets
 - Improving Technology Design & Performance
 - Monitoring Impacts of Interventions

Clear Indoor Air Partnership Projects



APROVECHO/ETHOS



- APROVECHO works to develop energy efficient, nonpolluting, renewable technologies that reflect current research but which are designed to be made in most any country. Produces technical information, testing center, etc.
- ETHOS is Engineers in Technical and Humanitarian Opportunities of Service; non-profit organization whose purpose is to facilitate research and the development as well as partnerships. ETHOS conference is probably the largest “stove” conference annually.



Some online Resources

- Partnership for Clean Indoor Air:
<http://www.pciaonline.org>
- APROVECHO:
<http://www.aprovecho.org/lab/home> and
video at <http://www.stovetec.net/us/index.php>
- Bioenergy Lists:
<http://www.bioenergylists.org>: technology and
discussion lists tracking projects
- WHO: <http://www.who.int/indoorair/en>