

# **Nine Top-Lit UpDraft (T-LUD) Gasification Advances of 2005**

A presentation at the ETHOS 2006 conference by:

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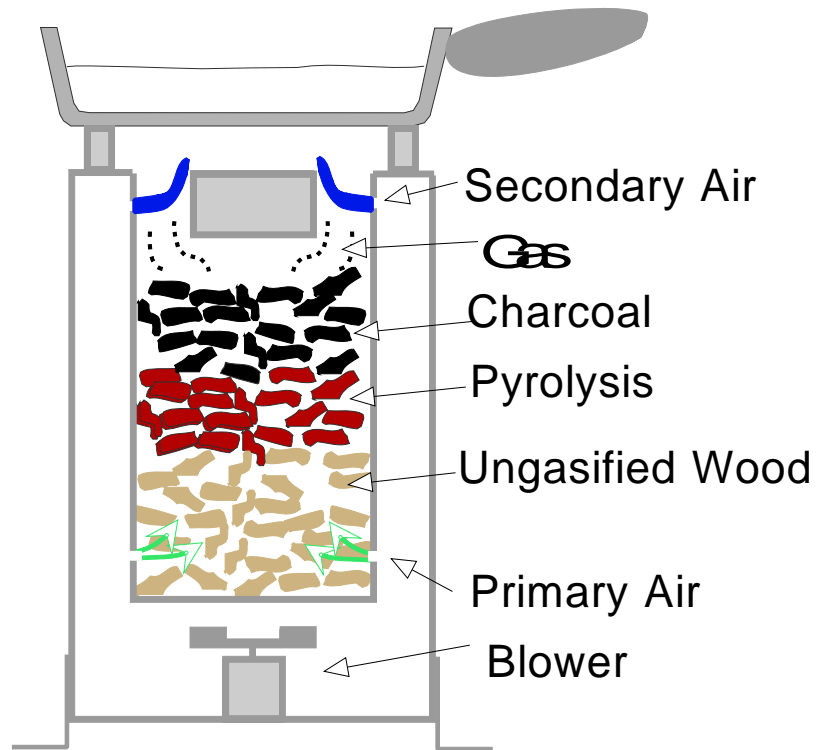
# What is Top-Lit UpDraft (T-LUD) gasification?

- A distinctly **new form of *controlled* combustion** conceptualized in 1985 by Dr. Thomas B. Reed.
- **Highly efficient burning of dry biomass** such as woodchips, corn cobs, and small briquettes in cookstoves appropriate for Third-World situations.
- **Flaming pyrolysis at the top** of a column of chunky dry biomass is starved of oxygen, resulting in **pyrolytic gases (“smoke”) moving upward** to where fresh secondary air enters, resulting in **clean combustion of the gases.**

In the twentieth anniversary year of T-LUD gasification there were nine (9) accomplishments in three categories:

- A. Reed's Woodgas Campstove [with battery-powered forced air]
- B. Anderson's Juntos "Model B" T-LUD gasifier [with natural-draft air]
- C. Belonio's Rice Husk T-LUD gasifier [with electricity-powered forced air]

# # 1. Reed's Woodgas Campstove [with battery-powered forced air]:



- Was scientifically measured as the cleanest burning of eighteen biomass stoves tested.
  - Research conducted at Aprovecho facilities.
  - Reported in a Shell Foundation publication.

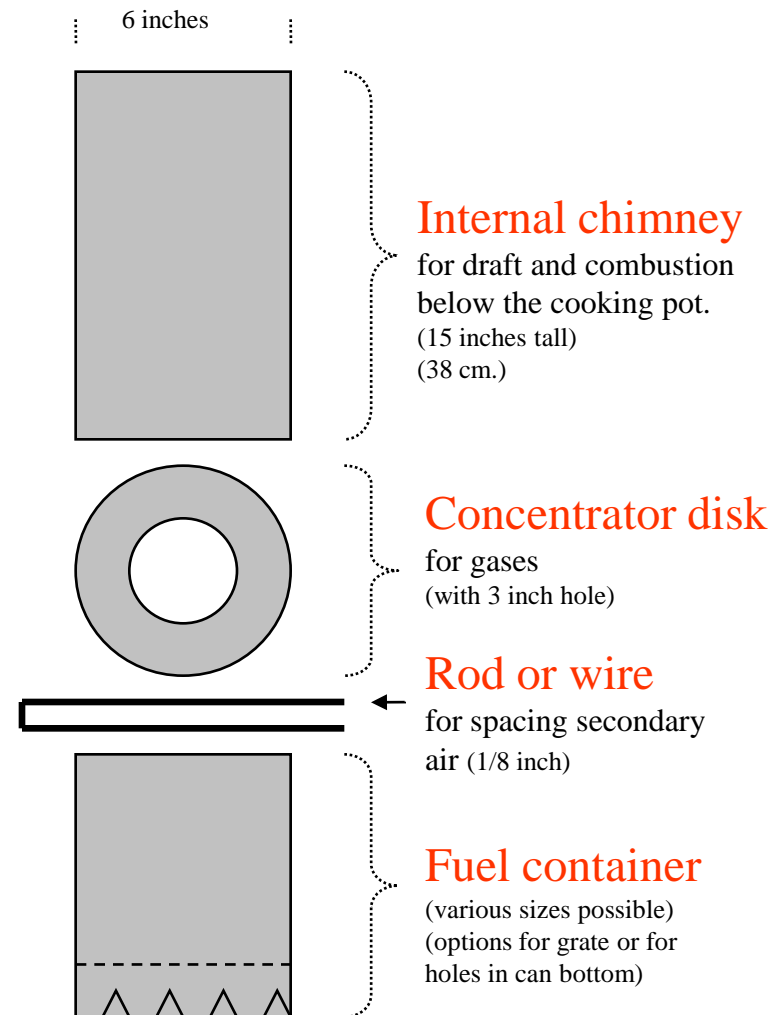
## #2. Reed's Woodgas Campstove [with battery-powered forced air]:



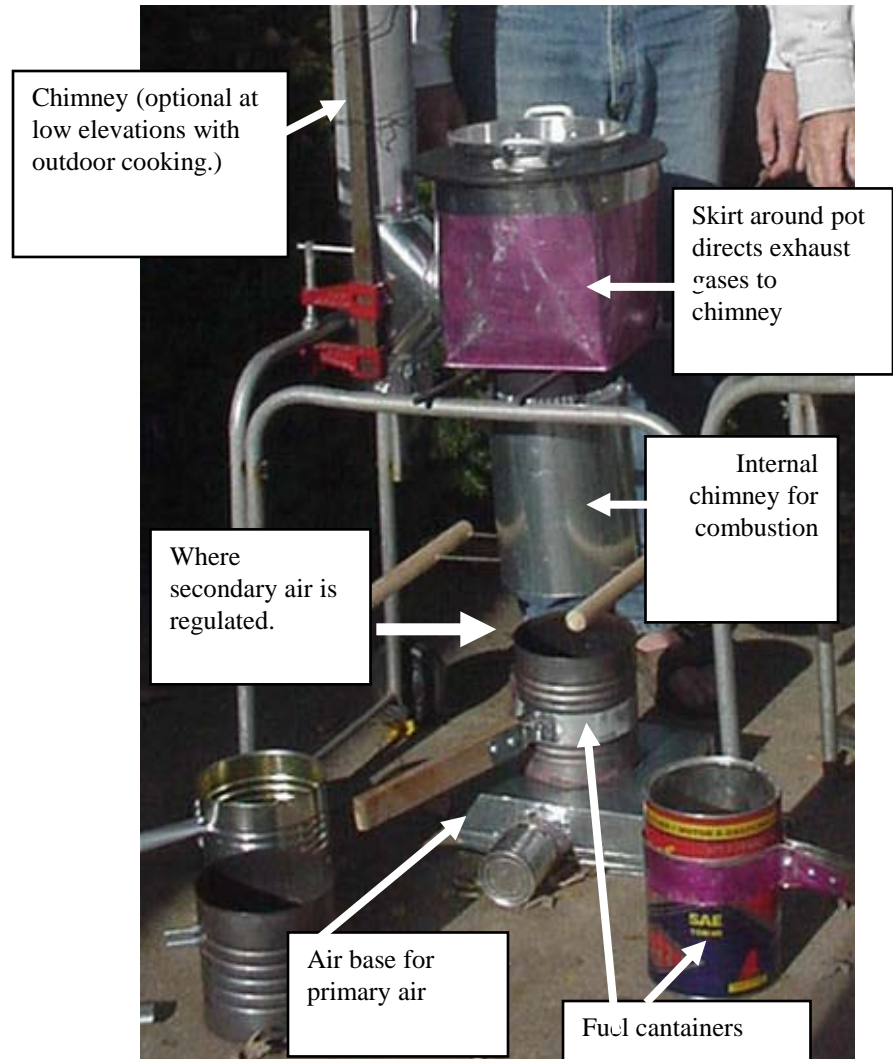
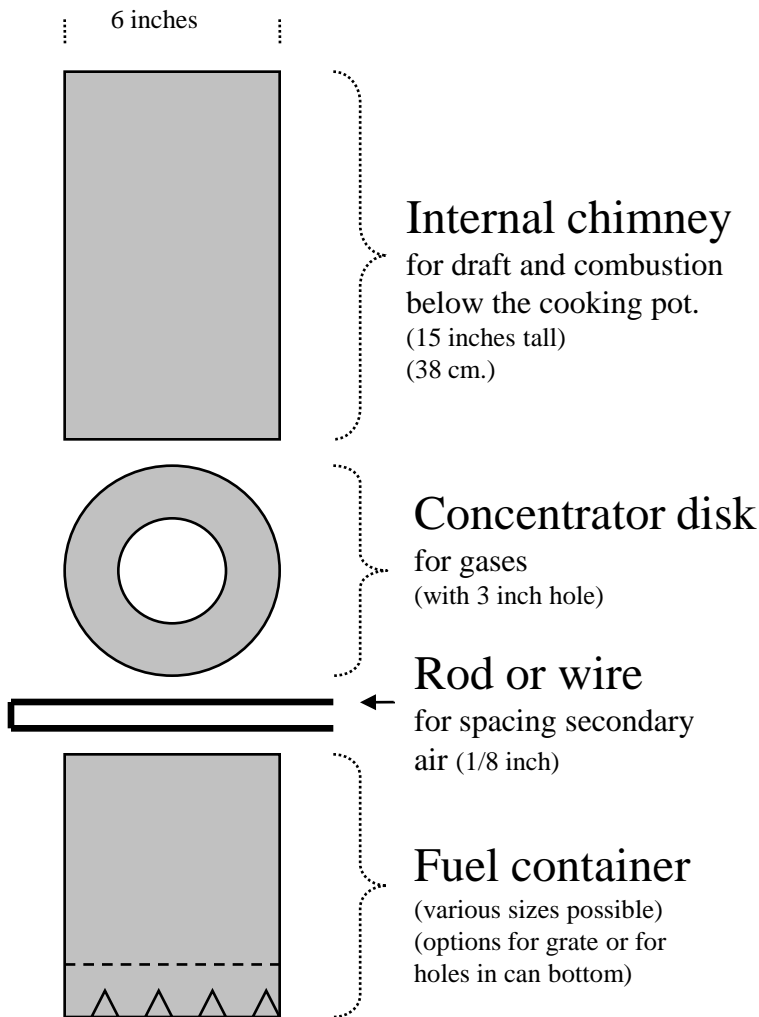
- Is now commercially manufactured and marketed for under US\$100.
  - New units are manufactured in Mexico by an American company.
  - An initial pilot production of 200 units was in 2003.

# #3. Anderson's "Juntos B" T-LUD gasifier [with natural draft air]:

- Design parameters of the gasifier and combustor were finalized in August 2005.
  - Four pieces of metal
  - A full stove requires support structure and application device.

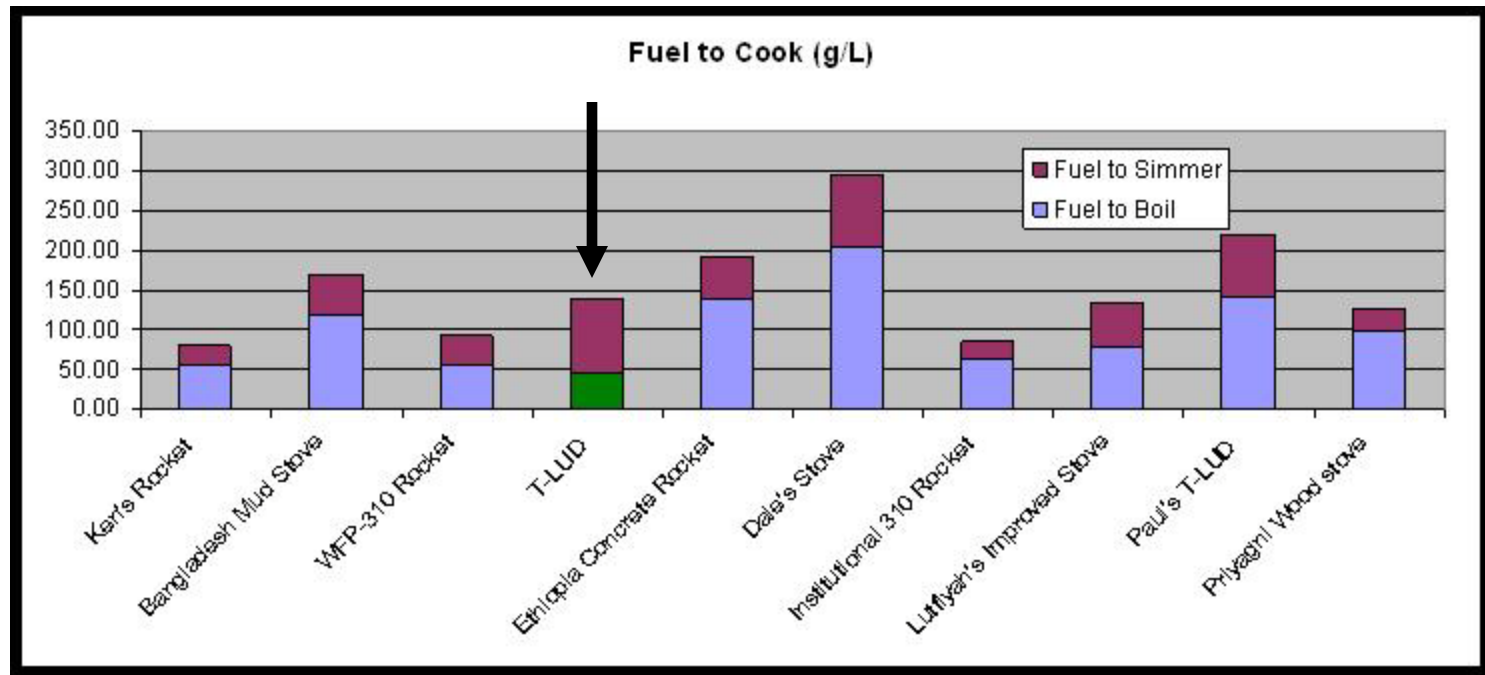


# Anderson's "Juntos B" T-LUD gasifier [with natural draft air]:



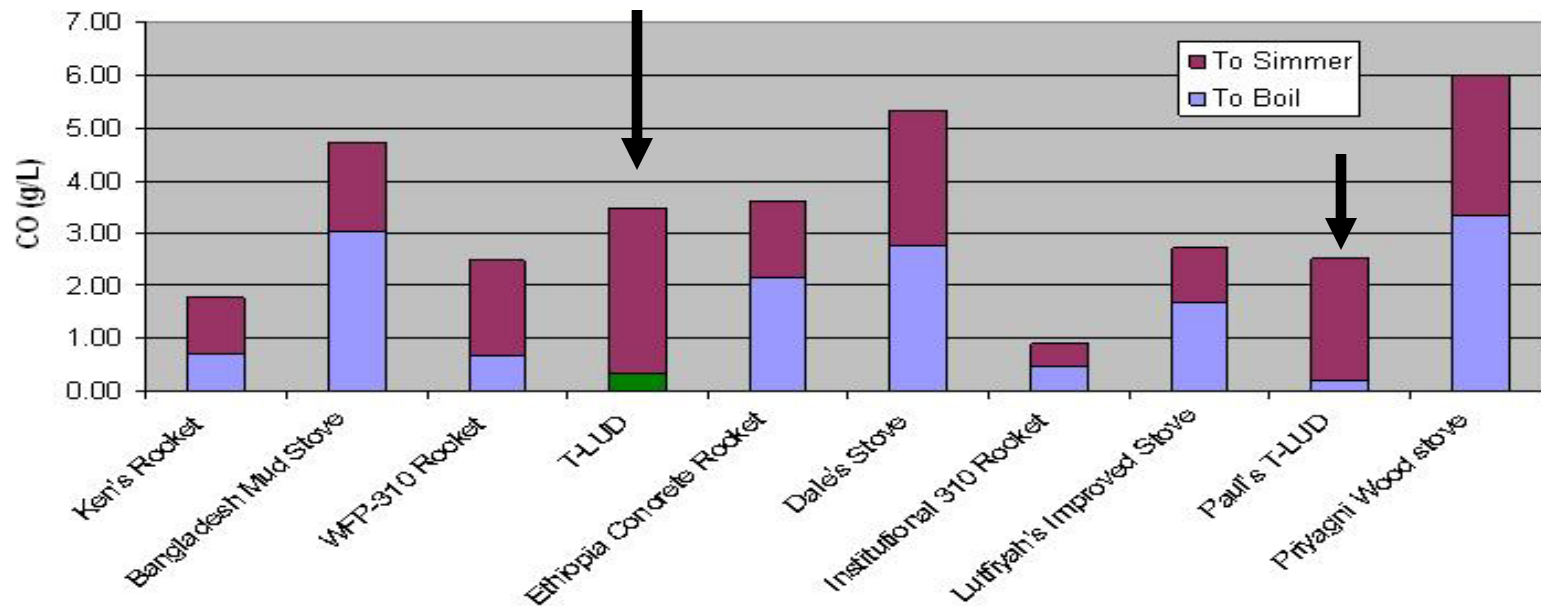
# #4. Anderson's "Juntos B" T-LUD gasifier [with natural draft air]:

- Was measured and judged the cleanest burning of nine natural-draft biomass stoves at Stoves Camp 2005.

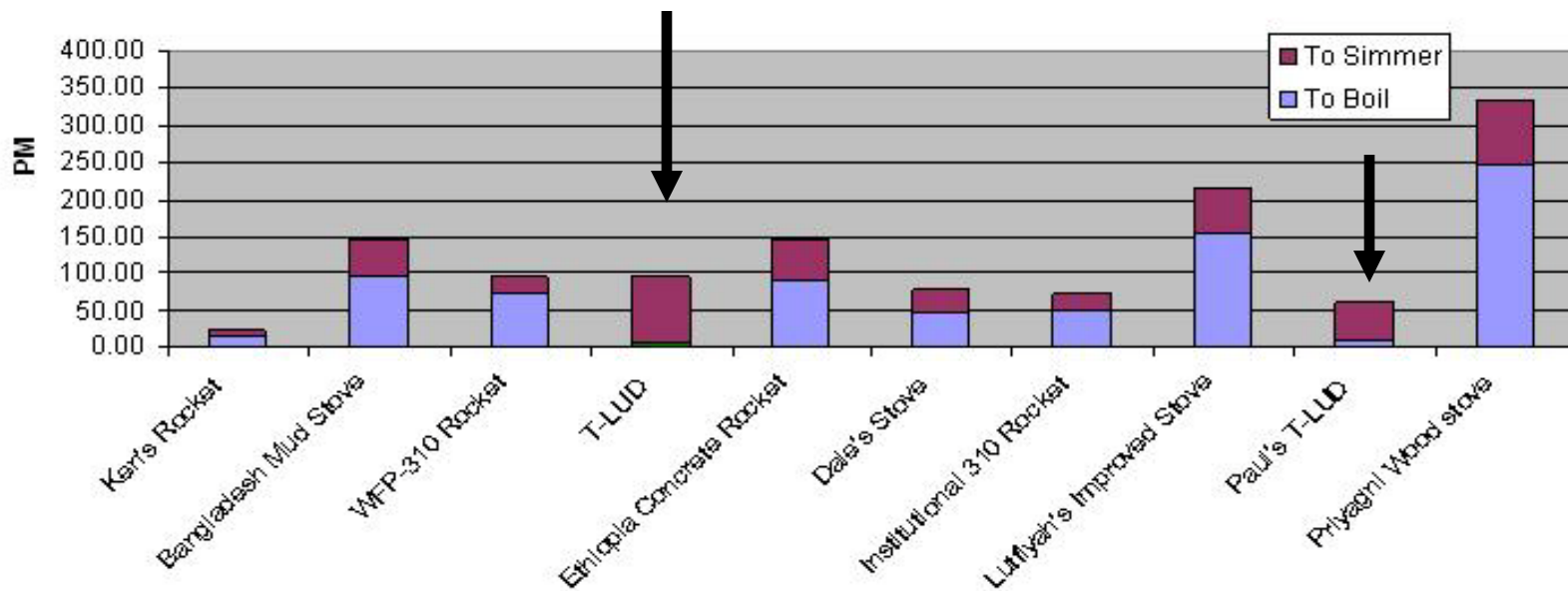




### CO Emissions to Cook



### PM to Cook



# #5. Anderson's "Juntos B" T-LUD gasifier [with natural draft air]:

- Entered into production and marketing in India, with some models under US\$20.







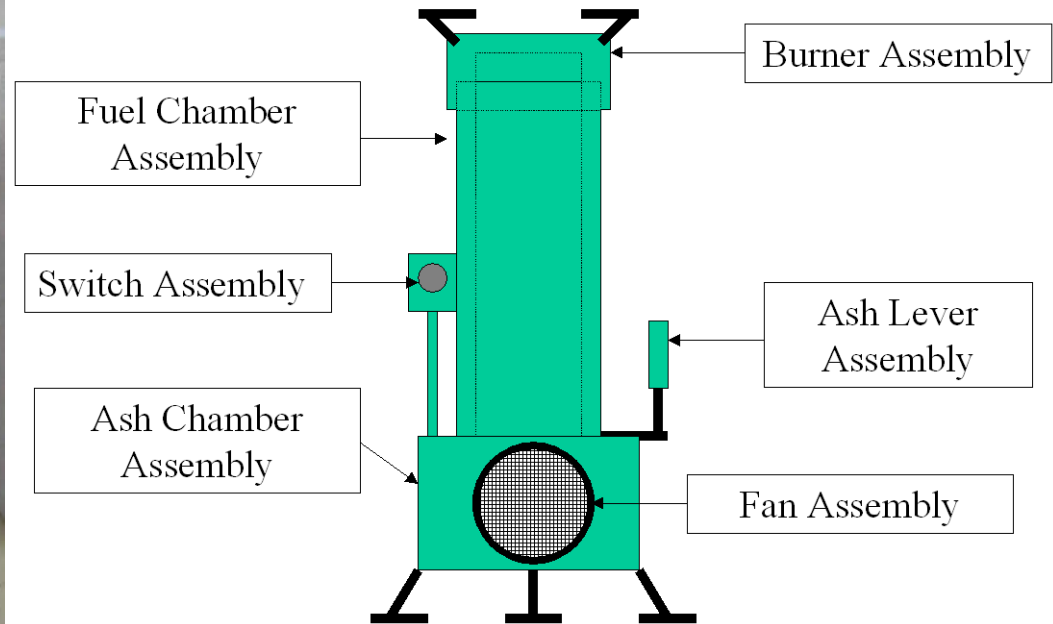
# #6. Belonio's Rice Husk T-LUD gasifier [with forced air]:

- Achieved the first consistently successful T-LUD combustion of a fine-particle biomass waste, specifically rice husks.





# Belonio's Rice Husk T-LUD gasifier [with forced air]:



Schematic Drawing of Rice Husk Gas Stove

# #7. Belonio's Rice Husk T-LUD gasifier [with forced air]:

- Is the first T-LUD gasifier with complete gasification (both pyrolytic and carbon gasification), yielding a consistent light-blue flame and low emissions.



# #8. Belonio's Rice Husk T-LUD gasifier [with forced air]:

- Successfully demonstrated remote (delayed) combustion of gases from a T-LUD gasifier (all others use close-coupled combustion).





# #9. Belonio's Rice Husk T-LUD gasifier [with forced air]:

- Began limited production in the Philippines, with an approximate cost of US\$200 per unit.



Alexis Belonio and some of his stoves.



# Summary of the nine accomplishments

- Three (3) refer to **commercial stove production**.
- Three (3) refer to recognition for **clean combustion**. (Two measured and one visual.)
- One (1) refers to using **natural draft** and low costs per unit.
- One (1) refers to **fine-particle agro-waste fuels**.
- One (1) refers to **remote combustion** of the gases.

# Discussion of near-future international stove-use activities.

- In **India**, with ARTI (led by Drs. A.D. and P. Karve)
  - User feedback from 20 households (Jan/Feb 2006)
  - User feedback from 100 households (March/Apr 2006)
  - Inclusion in ARTI's work with Shell Foundation.
- In the **Philippines**, additional models and sizes.
- In **Bolivia**, with CEDESOL (with David Whitfield)
  - Initial stove production and installation (Feb/Mar 2006)
- In southern **Africa**, pending sponsorship.
- In **additional areas** based on requests for assistance and funding.

# Research and Development Topics for T-LUD gasifier stoves

- Materials:
  - Use of ceramic for stove construction & metal protection.
- Sizes: Smaller and larger versions
- Forced air versions:
  - Supply, costs, and benefits of blowers/fans
  - Standardized blower/fan product for T-LUD forced air
- Gasification research:
  - How is the blue flame of Belonio's gasifier produced?
- Fuels of all types: Making waste biomass into fuels.
- Applications of the heat and user-driven issues.

And now, an added surprise!!

# An Introduction to Small Multi-Draft Continuous-Feed Gasifiers

A presentation at the ETHOS 2006 conference by:

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# Multi-Draft Gasifier (MDG) with Continuous Feed of Biomass Fuel

- Pioneer work done in the 1990's by Mr. Agua Das of Lakewood, Colorado.
- Variations for a larger natural-draft unit made in 2005 by Dr. Paul S. Anderson of Normal, Illinois.
- Designs and prototypes in 2005 - 06 by Mr. Paul W. Wever of Goodfield, Illinois, and Dr. Anderson.

# Multi-Draft Gasifier (MDG) with Continuous Feed of Biomass Fuel

- Bottom-lit mainly up-draft operation.
- Air enters in three controlled positions:
  - Upward at bottom, sustaining the combustion and gasification of the red-hot char.
  - Downward through the biomass fuel, promoting the flaming pyrolysis processes.
  - Laterally near the top for partial combustion of the gases inside the gasifier.

- Pictures will be added to this presentation, but for the moment please see the printed brochure and the actual gasifiers on display at the ETHOS 2006 Conference.



# Notes:

- All current units require a chimney for essential natural draft, but forced air units are being developed.
- Units are currently only being sold to research and development entities for purposes of applications development.
- Prices range from US\$150 to \$600 for sizes ranging from about 6 to 200 liters (1.5 to 50 gallon) internal capacities, with heat outputs of approximately 15K to undetermined BTUs.







