

Gasification:

**A process common to all
biomass stoves**

**A presentation at the
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Holistic Cooking

- The Solution to World Cooking must be HOLISTIC and Tailored to each country
 - Must satisfy the cook
 - Must use locally available fuels
 - Must satisfy world needs
 - Must use local manufacturing
 - Must fit local customs

Wood does not burn.

**Only gases, vapors and char
from heated wood can burn.**

Two Parts of Gasification:

The first part of gasification is

PYROLYSIS

- PYROLYSIS occurs as biomass is heated until it is fully charred to the core, that is, having given up all volatiles.
- Presence or absence of AIR does NOT matter in calling this PYROLYSIS, (“primary air” generates the heat that drives the pyrolysis.)

Pyrolysis Cloud protects char

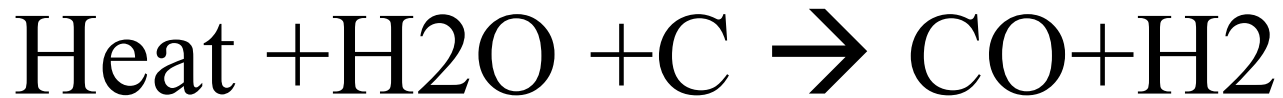
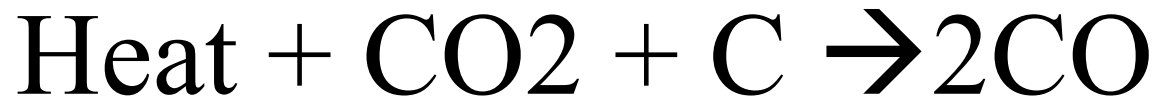
- A Char particle (solid carbon) can neither burn nor be gasified while it is shrouded by outpouring pyrolysis gases and vapors from the interior of the raw biomass. It remains black.
- Once pyrolysis is complete, then char can begin to glow, making possible the char gasification process.
- At very high heat inputs or turbulence, gasification around the particle edges causes simultaneous pyrolysis and gasification SPG

The Typical Yield Of Pyrolysis:

- 1/3 Char
- 1/3 Burnable Vapors/Tars
(condensable at ambient temp.)
- 1/3 Permanent Gases
(CO, CO₂, H₂, CH₄, N₂)

The second part is

CHAR gasification



Gasification occurs in all wood
combustion

“gasifier stoves” have the
gasification process more
clearly separated from
secondary combustion

Cocurrent Gasification=air and gas move the same direction

- Primary Air passes through non burning fuel to the flame front
- Air is available at the site of pyrolysis
- Then vapors/tars will be burned by the air with high heat release rapidly pyrolyzing wood to char
- Any hot combustion gases above 700C react quickly with the freshly produced char via char gasification to produce low tar CO and H₂ gases available for secondary combustion.

Threefold path to improved stoves

- Gasification
 - Secondary combustion
 - Heat utilization
-
- Improved stoves better separate and accommodate the conflicting needs of these three vital functions of all solid fueled stoves.

Gasification that is **“remote”** from the combustion of the gases has existed for decades in several formats, such as powering internal combustion engines.

- During WWII over a million vehicles were powered by WOOD.



Germany, about 1943. Mass production of gas producer vehicles, babert factory, where some 500,000 gas producers were manufactured during World War II. (E.E.Donath)

WWII GASIFIERS



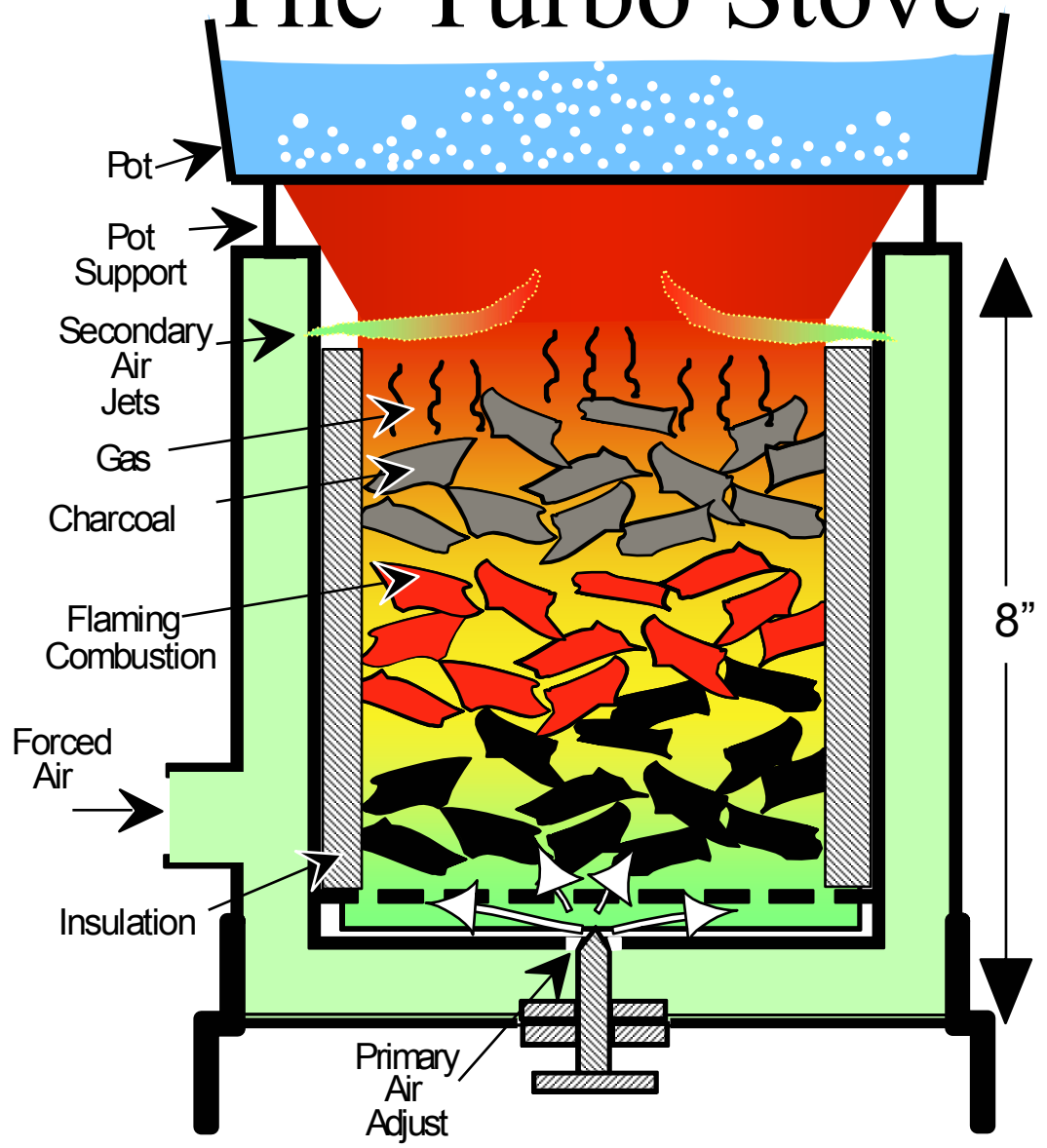
The gasification process can also be **“close-coupled”** to the combustion process.

- The gases are separated from solids
- Provided with secondary air
- Provided with ignition

The Turbo Stove



The Turbo Stove

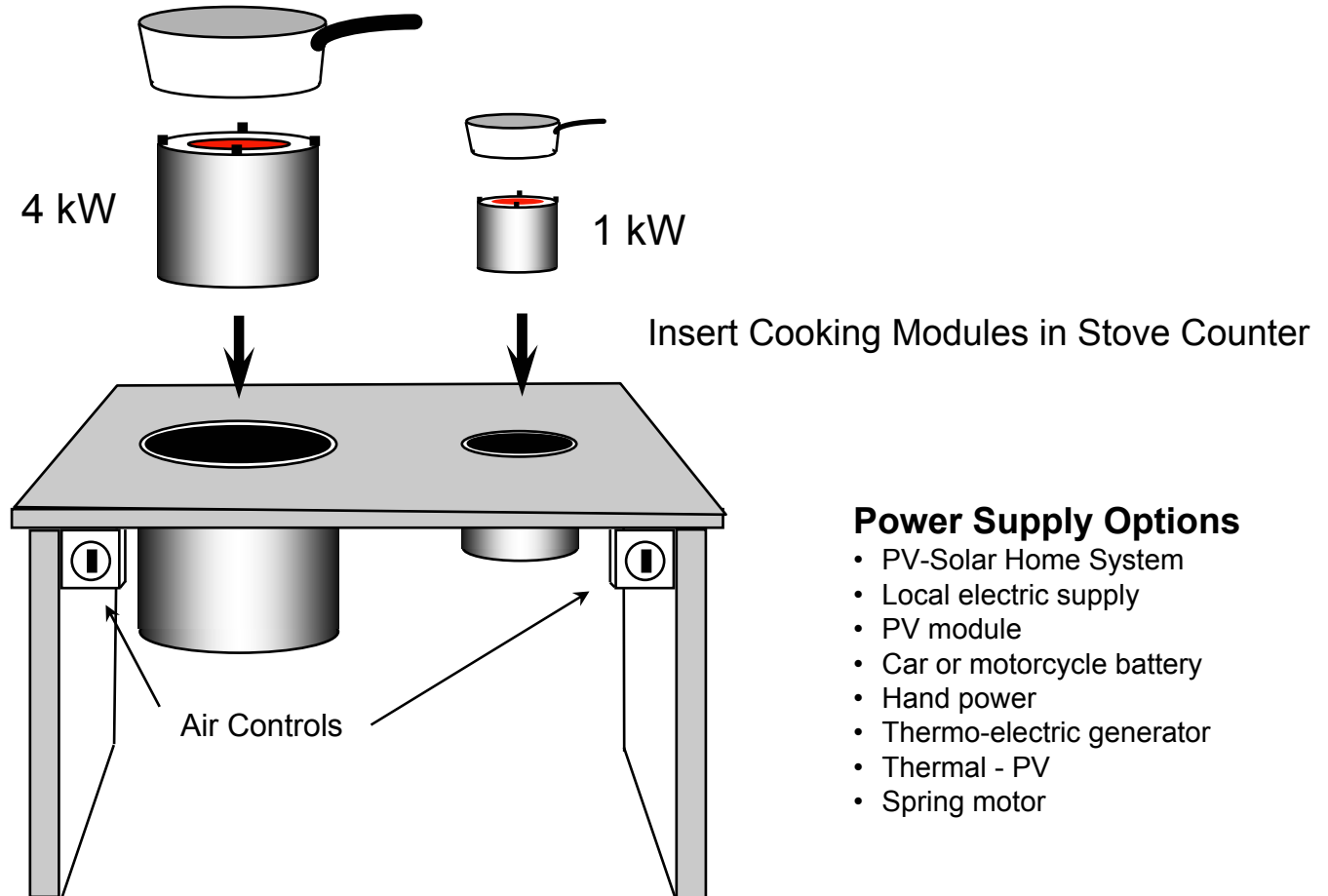


3kW Forced Convection Wood-Gas Stove Module

Comparative Stove Test



Wood-Gas Stove Assembly



Air Supply Options

- 12 V blower (1 watt)
- steam ejector
- bellows
- inflatable tube
- spring blower

Power Supply Options

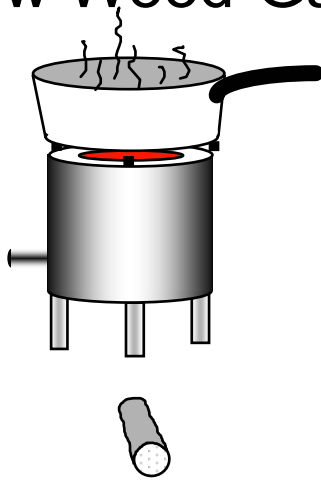
- PV-Solar Home System
- Local electric supply
- PV module
- Car or motorcycle battery
- Hand power
- Thermo-electric generator
- Thermal - PV
- Spring motor

Wood-Gas Stove assembly

Savings of Fuel Wood With New Wood-Gas Stove

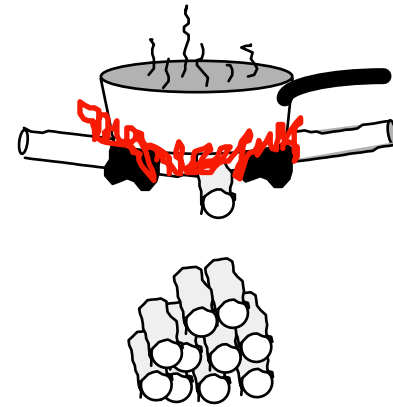
A Meal Cooked With:

New Wood-Gas Stove



.250 kg wood

Traditional Wood Fire Stove



2.5 kg wood

10 X More Wood



Fuel Savings

Starting Point



Kitchen with flue



Turbo Stove in Kitchen



Ward

Ward , Colorado

Three burner wood gas stove
Individually adjustable burners
Removable tincanium fuel
magazines have lasted 3 years



Gasification: A New Stove Capability

Permits proper air fuel ratios premixing and the
CLEAN combustion this gives you.

More compact, lighter, and smaller than equivalent
wood stoves (see the WoodGas Camp Stove)

Uses significantly less fuel than traditional stoves

Uses a wide variety of biomass fuels

Gasifier Stove Options

- Natural draft/forced draft
 - Inverted downdraft/Top lit/Charcoal Making
 - Tar burning, char making
(downdraft=cocurrent)
 - Char burning, tar making
(updraft=countercurrent)
 - Batch fed/ Continuous operating

**GASIFICATION
of biomass permits
(and works best) with
accurate AIR/FUEL ratios
and pre-mixing for clean
combustion.**

The science of gasifier stoves
(and of all stoves)

requires

appropriate measurements
and abilities to regulated
the stoves

THE BEF STOVEWORKS



THE DWYER GAUGE





Pitot Tube and Gauge



THE BACHARACH SMOKE METER



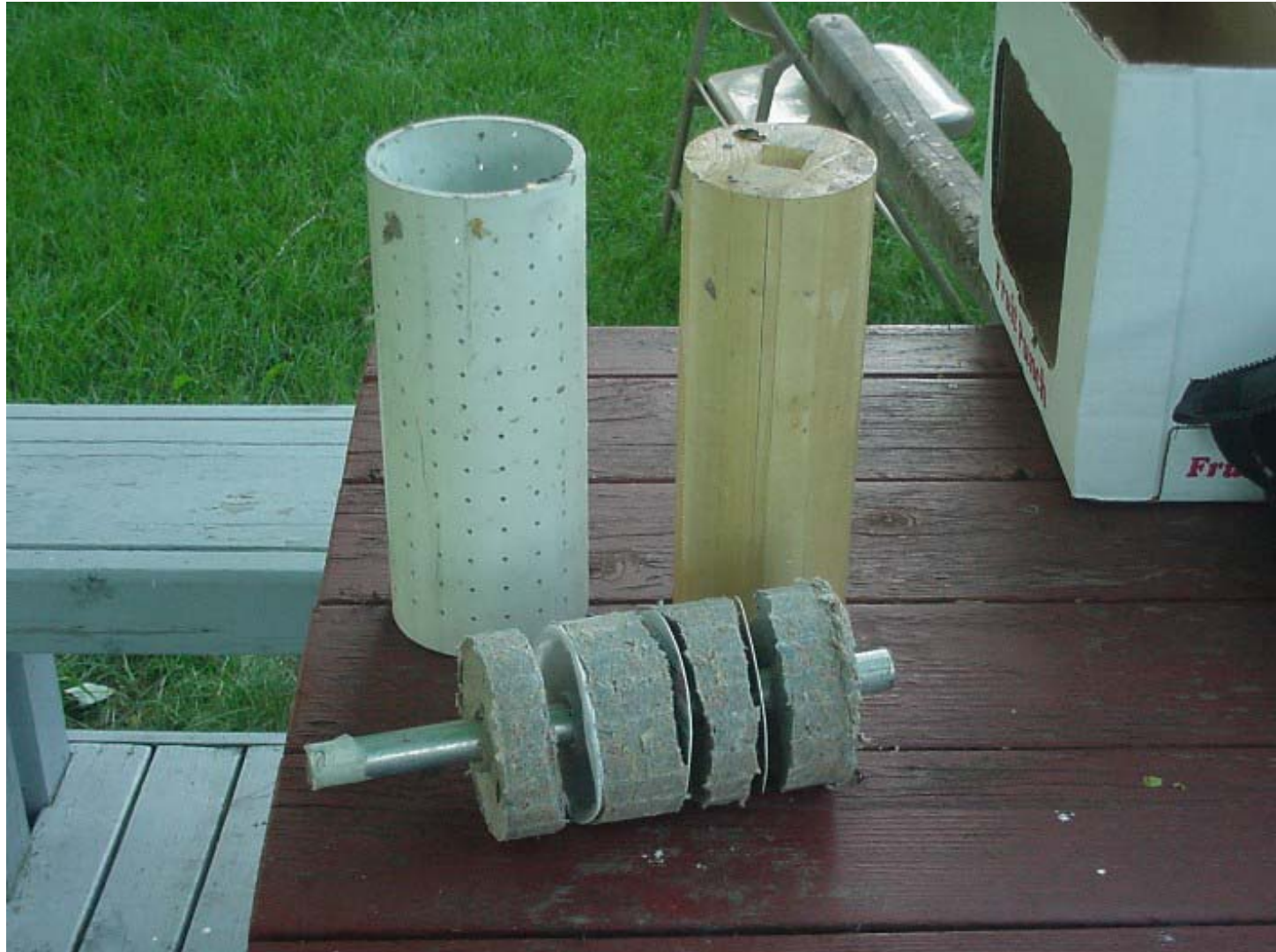
Creating gases separately also facilitates additional uses, such as new forms of lighting.



Reading by wood gas light



Paul Anderson Briquetting



Bagasse Pellets



Enjira Cooking in Ethiopia



THE SIERRA STOVE



TURBO TEA STOVE

