

## Exploring Biomass Gasifier Possibilities and Fuels in Central Guatemala

I was in Guatemala for 10 weeks recently, improving my Spanish for future stove projects, and I took a small commercial gasifier stove (Tom Reed's WoodGas T-LUD) with me as an example of a *fan assisted cook stove*. At the last ETHOS stove camp this general family of stoves tested exceptionally high in efficiency (and low in emissions), and this particular model had exhibited the best combination of properties of any stove analyzed. Using this stove as an example of the genre, I was determined to capture the hearts of Guatemalan cooks and easily convert



them all over to fan stoves fueled by waste agricultural products!



As I expected, like in most developing countries that I have visited, the majority of the rural population there spends an incredible amount of time pursuing firewood to cook their meals – huge trees felled by highway crews disappeared within hours (first converted to neat piles of kindling right in place), every night at sundown I saw people streaming in from the hillsides with their backs and heads piled high with wood, and the local markets were filled with both firewood and *carbon* (charcoal) sellers. Rural cook stoves tended to be of the half barrel type – an outdoor split oil drum with a smoky fire, cook pots configured crudely around the sides of it to adjust their temperatures – or very cheap thin sheet

metal charcoal stoves. My first attempt at a demonstration of modern stove technology was a near disaster – the village we visited was still in the rainy system so there was nothing dry to be found, requiring use of emergency fuels... charcoal started with *ocote* splinters, a pine fatwood used locally for starting fires only. The smoky mess that resulted (charcoal does not seem to start easily in general) did eventually end up heating the water for coffee, but it illustrated none of the potential of gasifiers or fan stoves for the neighborhood; as I packed the stove away, the only comment was “It certainly is *attractive*” and I knew I hadn't made any converts.



The lesson I learned was **the fuel comes first** – people don't want something new that isn't at least as easy to use as their present cook stove (no instruction manuals please), and having an easy supply of consistent, appropriate fuel was essential if people weren't to reach for the nearest inappropriate fuel first and become immediately discouraged.



I spent the next weeks scouring the Antigua area for waste biomass during the day (during “field trips” for my Spanish lessons), and doing stove experiments at night to stay warm. There are virtually no large industries so I chased stale tortillas in the tiny shops where they were made, woodchips and shavings from carpenter shops, searched in vain for enough avocado pits (they compost too fast to accumulate), used strange fruit pits (like *jocote*) and waste food products like rice/beans/corn/coffee, examined every imaginable tree pod or cone (the shade trees on coffee plantations had a very dense pod that burned beautifully!), tried old bread and cigarette butts, saw that coconut hull is the worst thing possible because of its low density, visited macadamia nut

and coffee plantations to talk with the owners, and generally was a local nuisance. My “research” on local fuels for fan assisted stoves resulted in a few observations:

- Again, the fuel is everything. Using the wrong one just wastes time and black smoke billows everywhere every time you try to relight it. Nothing turns off a potential user faster than a smoldering fan stove.
- Many things burn well, but without a *high density fuel*, batch stoves with a small capacity can be too clumsy to use – many waste types burn great but new fuel has to be added every minute (as with tortillas), and the instantaneous pyrolysis that can occur then creates too much flame.
- The proper fuel packing characteristics are essential for gasifier stoves – the air spaces between the fuel particles are necessary for the right air flow, so they cannot be too small (as with rice). Hot fuel particles also need to radiate to other nearby hot ones properly, so the gaps cannot be too large – more knowledge about the necessary characteristics of fuel beds is needed it seems



- First the stove must be lit – up draft gasifiers can be tricky to light so we should expect that people will use anything flammable (plastic grocery bags, gasoline, noxious solvents, etc.) to start with unless we describe alternatives. Paraffin (candle wax) has huge amounts of stored energy, stove alcohol (*alcohol de quemar* – mostly ethanol) is readily available, and the

traditional slivers of resinous *ocote* were suitable, but the choices are going to always be regionally specific.

- The addition of continuously variable fan speed control and a slightly higher voltage (from replacing two standard AA batteries with three rechargeable ones)

to this standard stove resulted in somewhat better control characteristics, but mainly at lower power levels – it can be difficult to adjust the firepower using just the fan voltage.

- Very few agricultural products actually go to waste – for example the coffee parchment (a thin skin removed from each bean) if compressed would burn beautifully, but one plantation owner I talked to already used it to feed worms and make compost, and he couldn't quite envision the benefits of diverting some of it to replace the diesel fuel he purchased now to run driers or distill alcohol.

Macadamia nut shells had the best properties of unprocessed biomass fuels I saw. Not as dense (not the nut shell density, but the *average bed density*) as commercial wood pellets (this stove has a capacity of 430 cm<sup>3</sup>, accommodating 400 g of pellets and 340 g of random broken shells) but the highest of natural materials I found and exhibiting excellent burning characteristics.



The plantation I visited had no use for shells, and just used them for walkways or mulch, and there are also macadamia nut culls which are too small to be worth extracting the nut meat (but the oil high oil content seems to cause them to burn uncontrollably). In another country these might be used as a metal polishing media, but here I had finally found good quality waste! Unfortunately this is a young industry in Guatemala so there is not much available.

A Castor bean (related to the more popular *Jatropha*) oil project came up while I was there – it grows as a weed easily and its seeds contain large amounts of oil of good quality; biodiesel productivity per acre may be among the highest after palm and coconut,



and the newspaper carried large articles touting its potential. Many countries in Central and South American are considering extensive planting of Castor to provide for more energy independence, but it is too soon to tell if this will actually take place. Besides castor bean plantations, multistrata agroforestry is a nice name for intercropping trees with vegetable and bushes, so that a piece of land starts to produce cash rapidly, even when the most valuable crops are young. In

Guatemala there are proposals for mixtures such as Silk Oak (*Grevillea robusta* – the Australian shade tree for coffee), Walnut, Castor bean, coffee, and vegetables where we see that there are several sources of food, oils, and biomass – potentially pods, shells, parchment, and dried pulp.

In conclusion, I believe that if you could identify key waste products then you would have a ready local market for stoves – all Central American countries have a stove manufacturing industry (for propane fired tortilla stoves) that could be taught to fabricate metal stove parts, and there is enough of a ceramics industry to fabricate Rocket components. But there may not now be enough large supplies of ready to use biomass (like nut shells), or they may be spread too far apart. If it is not yet time for waste biomass stoves, affordable better wood burning stoves are still needed in the near term. For now, modified gasifiers (such as the new Philips stove) and fan powered Rocket-type stoves will prove much more convenient in daily use, and that is what is required for widespread acceptance. Almost every place I visited had some electricity, and *everyone* there buys batteries for other uses (such as the ubiquitous radio for manual field work) – and luckily rechargeable batteries are becoming more common and affordable.

