Make charcoal?

Yikes!! Are you kidding?
Excuse me, but, please …

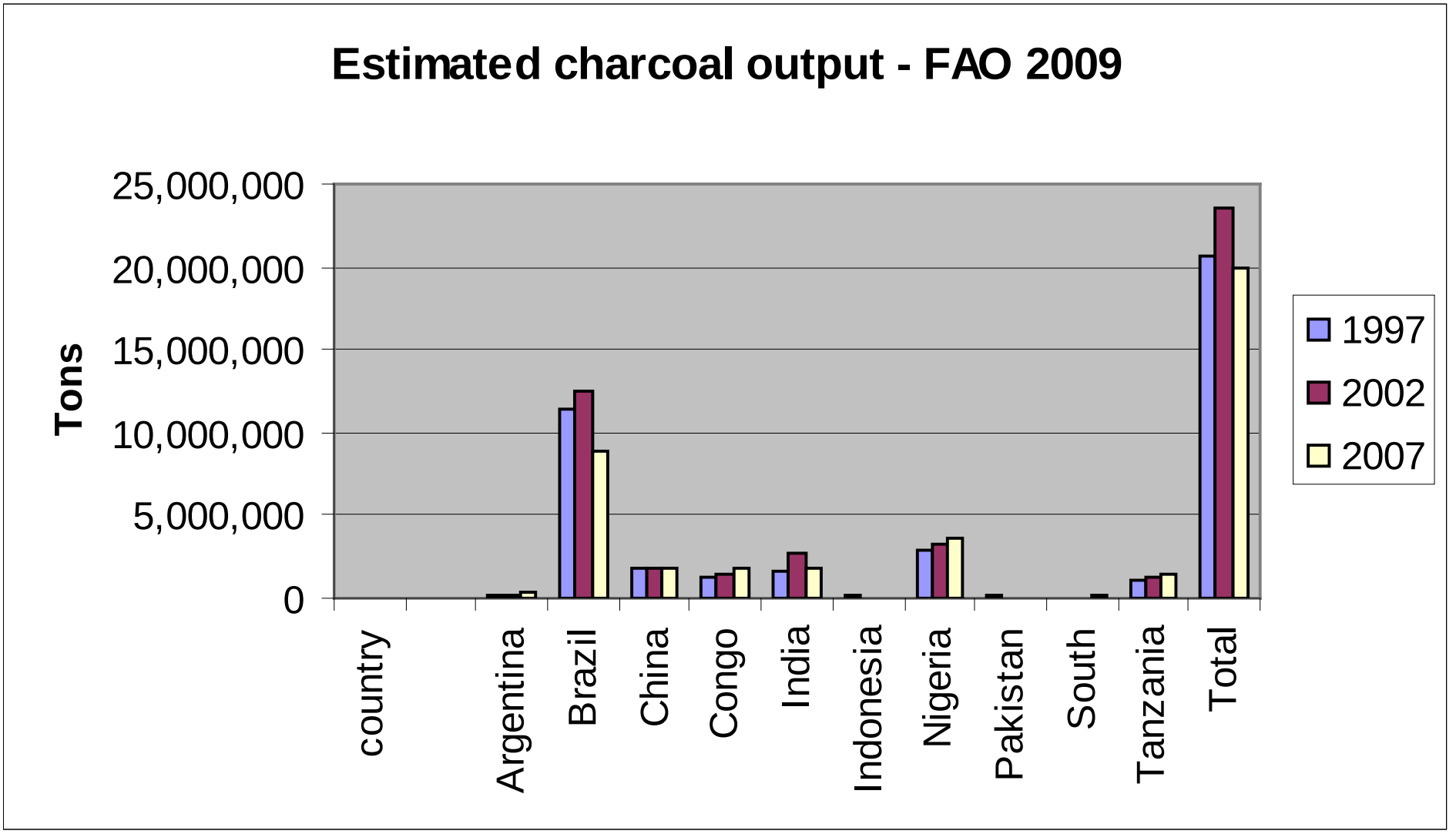
Make sense!

What's wrong with charcoal

- Made by traditional methods, upwards of 90% of the energy value of the wood is lost during production*
- Even with well-designed kilns, over half the energy value is lost (compared to the biomass it was made from)**
- The wood in traditional-method charcoal is only partly converted so it still creates high particulates when burned
- Most charcoal-burning appliances are inefficient and put out large amounts of CO pollution (CO can lead to pregnancy loss and low-birth-weight babies; it is suspected to contribute to heart disease deaths and cataracts, as well)

It also contributes to an unknown extent to ongoing deforestation

- In 1992, 24 million tons of charcoal were used worldwide; production increased about 1/3 from 1981 to 1992; that use continued to increase, even as the percent of total energy used has been trending down
- Nearly all is consumed in developing countries
- Africa consumes about 1/2 the world's production
- likely to be used as long as feedstock supply is available and demand from impoverished people and businesses in the developing world exists.


Estimated charcoal output - FAO 2009
Tons
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
country
Argentina
Brazil
China
Congo
India
Indonesia
Nigeria
Pakistan
South
Tanzania
Total
1997
2002
2007

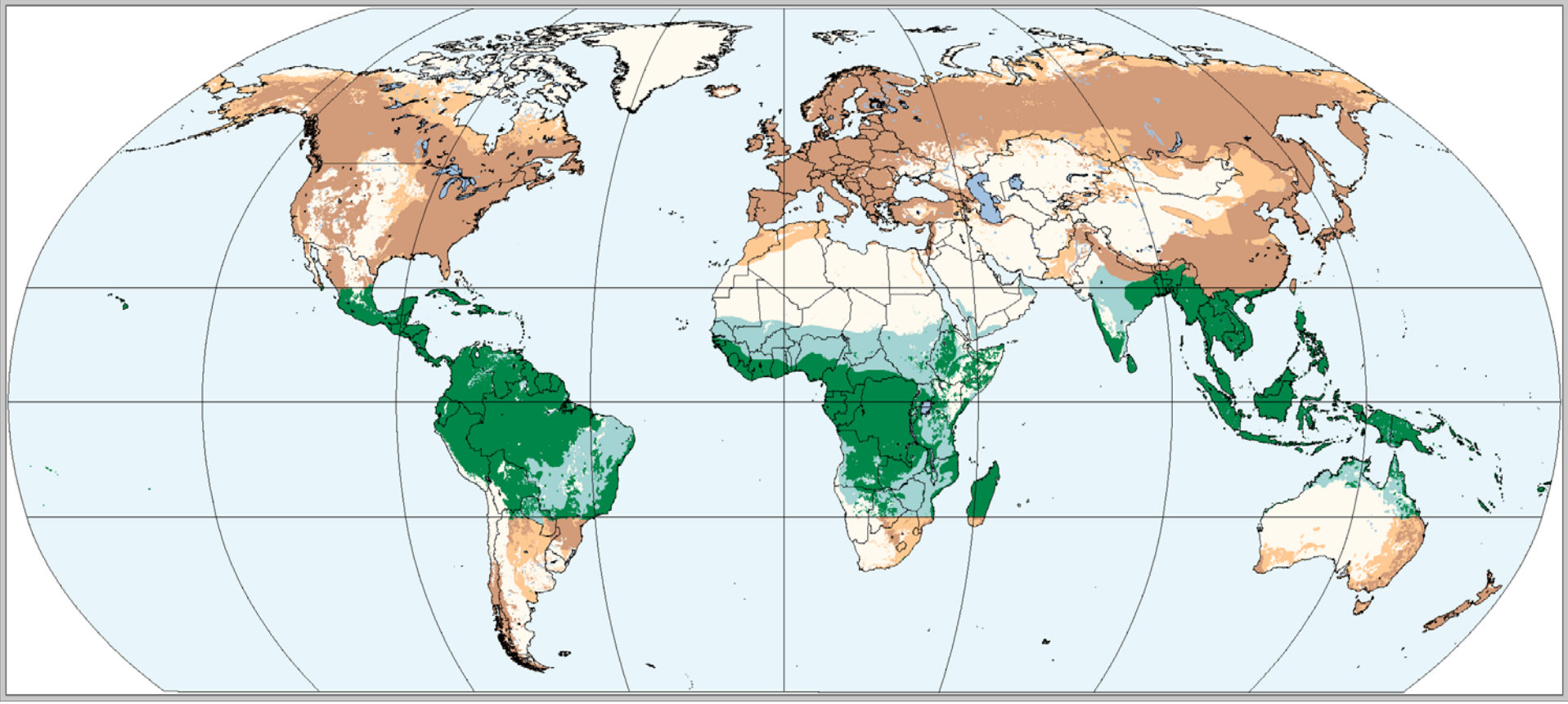
Original Global Distribution of Forests

Closed Non-Tropical Forest
Open Non-Tropical Forest
Closed Tropical Forest
Open Tropical Forest
Non-Forest
Water Bodies

Compiled by: World Conservation Monitoring Centre for the World Commission on Forests and Sustainable Development

Date: February 20, 1998 Projection Robinson

WORLD CONSERVATION MONITORING CENTRE



Current Global Distribution of Forests

Closed Non-Tropical Forest
Open Non-Tropical Forest
Closed Tropical Forest
Open Tropical Forest
Non-Forest
Water Bodies

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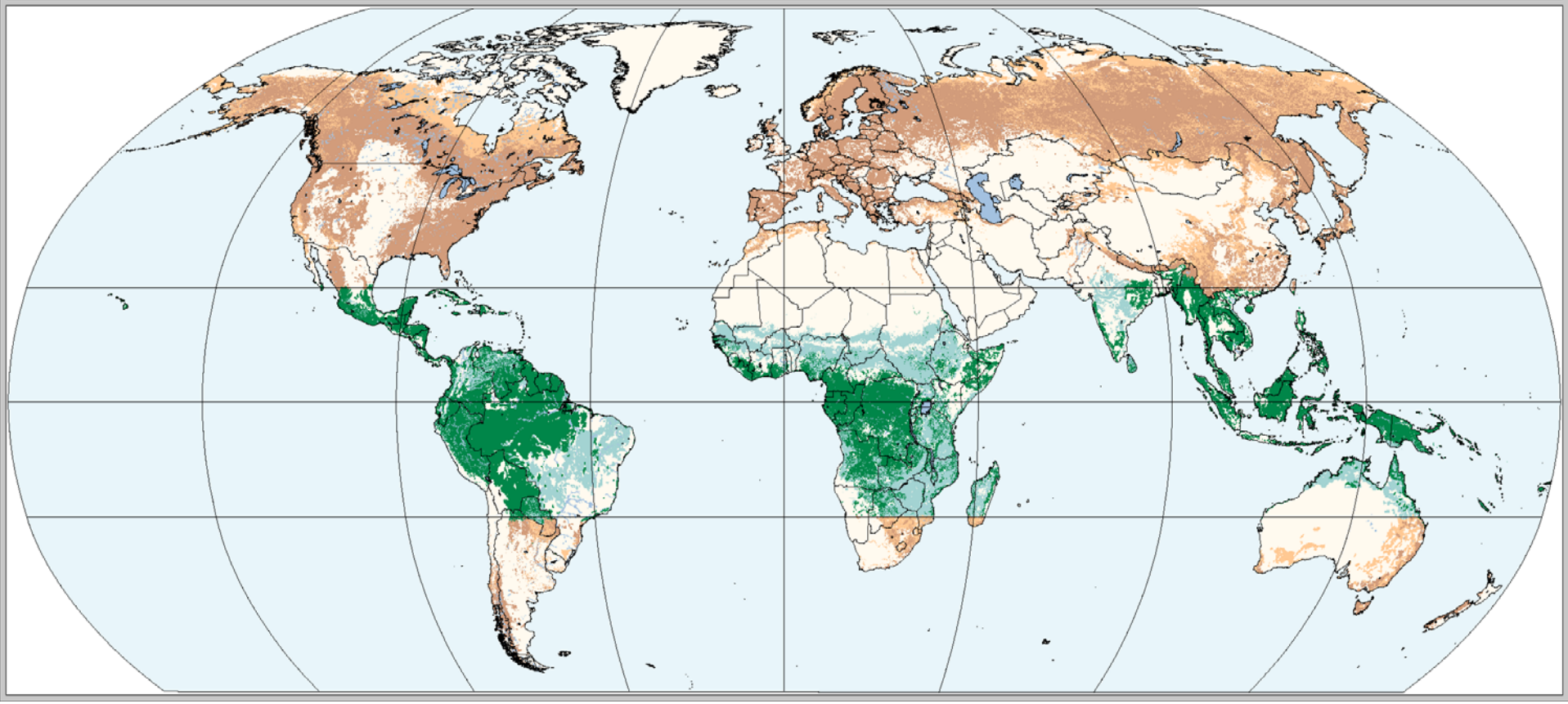

Globally, this is hugely important

- About 1% of the tropics are deforested yearly ($15x10^6$ hectare); in 2001, this was 35% higher than 10 years prior*
- When a forest is invaded, fire becomes more common, leading to lower recovery, faster soil erosion and more loss
- This leads to more flooding, then faster carbon release and new methane releases as decomposition is speeded up
- Flooding induced methane release is hugely important since its GHG potency is 20 to 30x that of CO2 itself

Expanding agriculture causes most forest loss but not the majority of it

- 55% of degraded land that doesn't readily go back to forests on its own is "other", that is it is not due to agricultural clearing
- Furthermore, land that was cleared for agriculture often becomes degraded, too
- In India, for example, the government has estimated that 1/3 of agricultural lands are degraded and not productive*

Loss of trees means less CO2 uptake and more GHGs produced

- About 25% of carbon emission comes from deforestation and it causes 20% of all GHG effect (including methane) directly or indirectly*
- In places, deforestation is causing people to lose sustainable livelihoods and become urbanized**
- As urbanization increases, energy demands increase*** meaning more charcoal and coal use

More bad news on the GHG front

- “Using solid biomass fuel can, in fact, produce higher greenhouse gas emissions per meal than fossil fuels, kerosene and LPG…” *
- Burning biomass also releases methane (CH_4), a GHG that contributes 15% of the forcing effect of GHG emissions on global warming
- inefficiency of solid fuel use in the homes of the poor results in somewhere between 2 and 6 times as much CO_2 production as does the use of cleaner fuels
- deforestation and poor agricultural practices leading to soil erosion can amplify the effect of biomass use as a fuel

Since charcoal is so bad, maybe it should be illegal to make it

- Guess what? In many places, it is. In many of the same places, it is the primary urban fuel.
- So obviously laws won't do it and we need to understand the reason people like it
- Replacing with "modern" fossil fuels would require long term subsidies to the poor and figuring out how to prevent diversion of subsidized fuel to the affluent for transport
- Replacing with coal is obviously more polluting
- So we must try to figure out how to eliminate the negatives of making and using it in poor countries

Typical African Story – 12/08*

- In Malawi, the government and environmental NGOs are trying to reduce dependency on charcoal for cooking because the charcoal trade has left most of the country's woodlands bare
- But most Malawians find it difficult to switch – a brand new hotplate costs around US$30; a locally made charcoal stove now costs around US$2
- In urban areas, those who use electricity also pay about twice as much for their cooking and heating
- The charcoal trade is illegal but research shows that 140,000 tons are produced every year

So what can we do about it?

- We can keep plodding along with promotion of more efficient biomass appliances, hoping that will displace charcoal (and prevent switching to coal)
- To make that successful, we have to create efficient systems to grow the biomass sustainably and transport it and sell it at prices that poor urban people can afford
- Transporting that amount of wood, keeping it dry and keeping it safe from rot, insects and thieves is hard
- That last point is a major reason why charcoal and coal will stay the fuels of choice in many developing countries unless modern liquid and gaseous fuels become cheap

So, might energy plantations for ethanol stoves be the best answer?

- Unfortunately, focusing on liquid fuel production from annual crops (such as ethanol from corn or sugarcane) requires high crop yields from productive lands to be economically feasible
- a strategy of plantations (of wood or perennial “grasses”) for energy production could better fit local ecology and simultaneous provide a basis for rural development
- This kind of plantation could be both biomass carbon storage and a charcoal production center providing rural employment and urban fuel

A more complete solution might be possible with some investment

- Creating biomass energy generation plants in rural areas could electrify those areas, provide power for local light industry development and send power back to urbanized areas if demand is high enough to support power line development in the reverse of its usual extension
- Using just 10% of non-forest, non-crop, non-wilderness lands could provide 50% more electricity by 2025 than was used in the developing world in 1995*
- Systems have been devised to make both electricity and charcoal; this could boost biomass efficiency enormously

- Conversion of lots of previously forested land to agricultural lands that are no longer productive means that there is potentially a lot of land available for use as biomass "energy plantations" without displacing important agriculture uses
- Growing of raw materials for renewable biofuels could then replace some fossil fuel use and thereby decrease GHG emissions directly if these are burned efficiently and continuously regrown
- 200 tons of carbon per hectare could be stored in a biomass plantation on degraded land over 100 years in India*; almost all that storage is in the first 20 years; thereafter, sustainable wood harvesting would leave the same amount stored

Some things already in the CDM "pipeline" seem incomplete*

- One CDM project proposal is to use high yielding eucalyptus plantations to supply wood for charcoal production with technology to reduce methane emissions by 70% from the current process
- This could keep small pig iron producers in Brazil from switching to coke as has already happened with larger firms, thus keeping the people working there employed in a sustainable rural business
- If they also found process heat applications for their charcoal "kiln", they would save the CO2 currently generated by those activities

Another good but incomplete proposal for biomass wastes

- Charcoal briquettes from abandoned/waste cellulosic biomass would be used to replace the wood used in curing of tobacco in the Ilocos Region in the Philippines
- Converting wastes to briquettes would put waste to good use and also control methane generation from biomass decomposition by flaring it during carbonization
- Its not clear why they haven't thought about using the heat of flaring for the drying and then selling the charcoal
- If no one else uses charcoal in their area, then using it as a soil amendment locally could increase farm productivity

Other agricultural wastes can also be turned into charcoal

- A team of researchers at MIT devised a method for charcoal production that uses the waste material from sugar cane processing (bagasse) to make an alternative form of charcoal
- Tests showed that the sugarcane charcoal was able to compete with wood charcoal on an energy density basis, and a rough economic analysis showed that it could be produced for about a third of the cost of the wood charcoal available in the local market
- But they also didn’t try using the process heat for another purpose; in this case, there is an obvious need to boil down sugarcane juice; dried bagasse is used for this elsewhere

Sometimes great ideas are abandoned for no good reason

- An engineer working in Burundi for ONATOUR (Office National pour la Tourbe, Usine Charbon de Biomasse) built a small “Bio Coal” Production Plant that worked well
- It used peat fines, coffee hulls, rice husks and bagasse that had all just been rotting in piles before
- Unfortunately, his financing was from a company that just wanted a trial run of “Bio Coal” to assess its market to try to sell a much bigger industrial facility to the government
- This was in 1992; civil war then caused the loss of all investment interest in this or the larger facility

There are also projects & proposals on the biomass electricity production end

- In India, the cost of power from a biomass gasifier has been calculated to be between 1.5 and 2.5 Rupees per kWh for remote areas whereas for diesel cost of power is between 8 and 25 Rupees per kWh
- In one area, the waste heat could cut about 40 to 50 per cent in the firewood consumption for arecanut processing*
- Some is already done; in Brazil, electricity generated on site from wood biomass (mainly residues) by 2007 was expected to be about 1.5 GW and to contribute to reducing GHG emissions 50 M tCO2 equivalent**
- If one used the flaring of volatiles for all the process heat needed, the same projects could also produce charcoal

Other wood users could also be switched to producer gas while making charcoal

- In India, lime processing in Shella block of Cherrapunji alone uses more than 70,000 to 90,000 tons of wood/year*
- Peter Scott has shown us how much wood is used for tobacco curing in smallholder farms; rocket barns may cut that 50+% but what if that grower was persuaded to use part of his land just for sustainable biomass to be used to make charcoal while providing process heat for curing
- Tea plantations also have wood plantations for their processes; they could use just the process heat if this was set up efficiently and then sell the charcoal
- A need for heat is common to many agricultural activities

And if there is no local need for any process heat?

- Electrification is essential for the rural development that can keep people from urbanizing but, as noted, diesel generators have proven expensive and difficult to maintain
- Extending electric lines from large power dams and power plants is expensive and both also increase GHG emissions (and other pollution from coal burning and mining)
- Electricity production just needs heat to drive the generator load; that could be supplied by producer gas in small systems with turbines or other means (even rejiggered gasoline engines are a possibility)

A clean, efficient system for producing Charcoal, Heat and Power (CHaP)

- Designed by Cardiff School of Engineering
- This was a prototype not a production model; I was unable to get an email answer about future plans from the authors
- Used a pressurized vessel for pyrolysis; planned multiple reactor vessels using producer gas from one to heat up the next when the first is running low on its batch of biomass
- The producer gas then ran a turbine to make electricity via a special combustor incorporating novel vortex collector pockets to remove ash particles down to 5 mm without the need for cyclone collectors in the system and to deal with the variable mix of medium- to low-calorific gases
- High quality charcoal yield was 38% and the hot wood gas had a calorific value of approximately 9.8 MJ/kg of wood

In summary

We can make charcoal make sense

- In large areas, charcoal won't go away until the forests are depleted enough to make fossil fuel/electricity competitive
- We need to prevent that since the likely replacement fuel for power generation and in-home use by the poor is coal
- Since current charcoal production is so inefficient and dirty, any clean system for using waste and/or plantation biomass to make charcoal is bound to be preferable
- If you use the producer gas to do something else that previously would have used fossil fuel or wood directly, there is an additional environmental benefit
- Creating such systems could create sustainable livelihoods for people who might otherwise need to urbanize or invade the forest for charcoal production or hunting bushmeat