Consider Woodgas Cookstoves for Haiti

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[Replaces 15 May 2017 document entitled: Woodgas Cookstove Proposal for Haiti: Expanded]

Summary: Woodgas stoves have significant advantages and should be included in future cookstove activities in Haiti, especially in the forthcoming Canadian-sponsored efforts.

1. *An earlier version* *(dated 15 May 2017) is replaced by this document.* This document is open to all readers, but is particularly directed to the Global Alliance for Clean Cookstoves (GACC) and to Global Affairs Canada (GAC) in their consideration of alternative plans for major assistance (said to be 25 to 50 million dollars) for cookstoves in Haiti. **This information is in response to the GACC request for comments / inputs following the early 2017 release of the initial design phase strategy.**

2. Woodgas cookstoves (also called TLUD (tee-lud = Top-Lit UpDraft) stoves and micro-gasifier stoves) are rated as the cleanest-burning stoves that utilize dry biomass fuels [see joint publication by GACC and ESMAP (2015, Tech Rpt 007, figure 1)]. The following table is excerpted from a recently-published 4-page comparative document, "Classification of Stove Technologies and Fuels" (http://www.drtlud.com/wp-content/uploads/2017/04/Stove-Classification-2017-04-10.pdf). [Highlights have been added here.]

Classification of Stove Technologies and Fuels (V. 1.0 – 2017)

Div	Not-Clean Cooking Solutions (ICS)				Modern Advanced Clean Cooking Solutions (MACCS)					
Fuel	Solid Biomass as Solid Fuel: Wood, dung, agro-refuse, charcoal, (Coal is localized and fossil solid fuel.)				Solid Biomass as Initial Fuel for Creation of Gases & Liquid Fuels			Non-Biomass Fuels		
Cooking Technologies	**Base-line: Three-stone fire**	**"Improved Cooking Solutions" (ICS)** Legacy & Basic **ICS** Stoves	Inter-mediate **ICS** Stoves	**Char-coal ICS** stove	**Advanced Clean Cooking Solutions (ACCS)** Combustible gases and liquids for cooking are created ("refined" or "derived") from initial biomass that undergoes an intermediate process.			**Fossil-Fuel Stoves** Processed petroleum to become gases.	**Electric Stoves** Electricity remotely generated. Much from fossil fuels.	**Solar Stoves** Depen-dent on sunlight.
what is Combusted?	**Bio-mass as Solid Fuel**	**Bio-mass as Solid Fuel**	**Bio-mass as Solid Fuel**	**Char-coal** has only 30% of energy of wood.	**Woodgas from Biomass:** Gas-burning with gases from solid dry biomass; makes char.	**Biogas from Biomass:** Gas-burning with gases from solid wet biomass.	**Liquids from Biomass** Ethanol, Methanol from biomass.	**LPG, NG** (nat. gas), DME, (Exclude kerosene) (Coal is solid and seldom clean-burning.)	**Electricity** Derived from renewable hydroelectric, solar, & (min) biomass. Also from fossil fuels (oil, gas, coal) and nuclear.	**No com-bustion** present in solar cook-stove.
Key Features and Stove Types	**Three rocks to support a pot;** Open fires and shel-tered fires. Many supple-mental stoves.	**ICS Clay, mud, brick, and simple metal to contain fire** Artisan produced.	**ICS Rocket-style stoves** w/ high fuel efficien-cy and moder-ately clean burning.	**ICS Char-coal stoves** cause defor-esta-tion and high C0 emis-sions.	**Pyrolysis** in fan-assisted or natural draft **TLUD gasifiers** produce gases & "C negative" charcoal with re-sale value. **TChar stoves** can replace charcoal ones.	**Anaerobic digestion** of biomass decaying in containers yields combustible gases. Always local production; biogas is never transported.	Industrial **distillation** of biomass yields **liquid alcohol** to burn in appropriate stoves. Many as supplemen-tary.	**Processed fossil fuels, with high fuel and combustion efficiencies;** LPG in metal cylinders or NG via pipelines. Subsidized. "C positive".	**No combus-tion** present in the stove; dependent on grid power; batteries are not sufficient. Electric or induction heating elements in a stove structure.	Reflective "dish" or solar-collector box, with need to **orient toward the sun.** Solar box ovens.

Adapted and expanded from *The State of the Global Clean and Improved Cooking Sector,* ESMAP 2015, Tech Rpt 007/15, Figure 1.1 (p. 13).

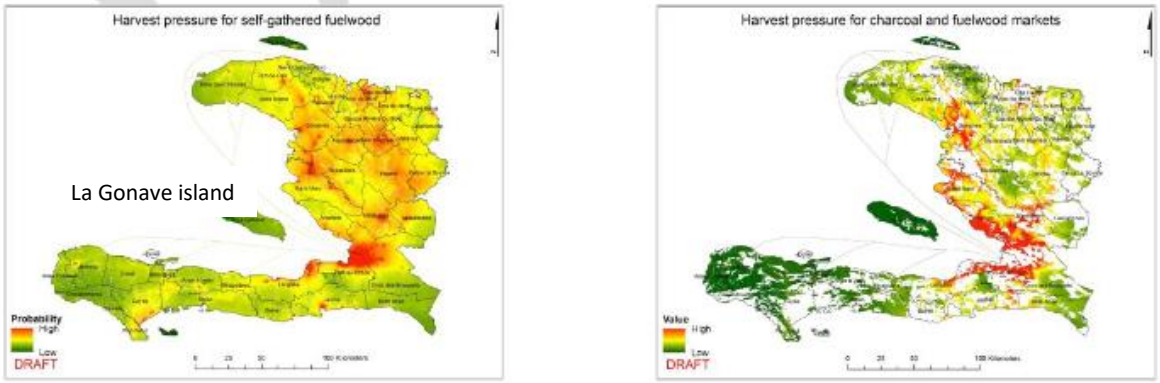
Woodgas stoves are **gas-burning stoves** that auto-generate combustible gases from dry solid biomass primary fuels such as wood, pellets, briquettes, maize cobs, and dung. Although they APPEAR to be burning the solid fuel (and are commonly called wood-burning stoves), they are in fact pyrolyzing the solid fuel, leaving behind charcoal while generating combustible gases that are burned a few inches (cm) higher in the stove. The physical ***separation of gas creation from the location of gas burning*** is the distinctive hallmark of clean combustion "gasifiers" of all sizes. Therefore, woodgas stoves are the ONLY solid biomass (wood-fueled) stoves in the classification of Modern Advanced Clean Cooking Solutions (MACCS). Technical explanations of gasifier stoves, including the distinctive Migratory Pyrolytic Front (MPF) in Top-Lit UpDraft (TLUD) technology that produces charcoal while doing the cooking, are available among the resource publications at the Dr TLUD website (www.drtlud.com/resources).

TLUD stoves are especially well suited for Haiti because they produce significant amounts of charcoal while cooking with the created gases. By weight, charcoal from TLUD woodgas stoves is about 20% of the original biomass fuel, and contains about 30% of the original biomass energy, and about 50% of the carbon atoms.

There are many designs of woodgas / TLUD stoves, such as the one in the photo, the stainless steel "Champion" micro-gasifier which is made and used in India. This design and a few others should be seriously considered for pilot projects and eventually major projects in Haiti. In India, the factory price of this stove (with two fuel containers but excuding the pots) is US$35. The stove has a lifespan of seven years when properly maintained and repaired. Specifics of TLUD stove design options can be provided, including details of new versions with advantages of a fan for forced air (FA).

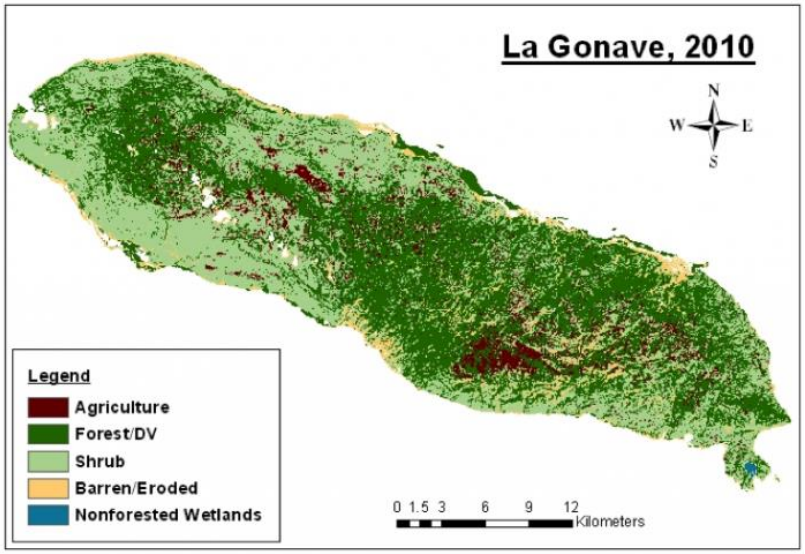
3. Biomass supply: Wood as a renewable fuel in Haiti is commonly thought of as scarce, with many reports citing less than 5% forest coverage remaining in the country. The World Bank, (2015) states Haiti's urban charcoal demand is estimated at "70,000 tons/year, outpacing the potential for sustainably produced charcoal, and is significantly impacting deforestation" (GACC, 2017). Certainly, there is biomass scarcity and even desolation in some locations, while some places such as La Gonave island and the southwest peninsula of Haiti have relatively more biomass (Figure below).

Figure 1. Harvest Pressure for Self-gathered Fuelwood (Left) and Charcoal/Commercial Fuelwood (Right)



(Source: GACC 2017, page 9.)

However, other studies based on satellite images and fieldwork place the national percentage of coverage at 32.3% remnant forest and trees (Churches et al. 2014). The island of La Gonave is 46 percent covered with forests and dense vegetation, and 40.4 percent covered with woody shrubs (White et al. 2013: 499). Much of the current supply of charcoal for Haiti is coming from the southwest peninsula and the island of La Gonave. An excellent summary of these studies is by Tartar 2016 at: http://www.envirosociety.org/2016/05/haiti-is-covered-with-trees . Clarification of reserves and supplies of biomass within Haiti will be useful.



This information raises hopes for Haiti's ability to supply sufficient renewable biomass for wood-burning stoves and for production of charcoal. Whatever the case of past and current practices that are indeed seriously detrimental, ***the introduction and use of woodgas TLUD stoves could greatly improve biomass and charcoal supply issues.*** (see calculations below).

4. Consumption of wood: The "Haiti Cookstoves and Fuels Market Assessment: Preliminary Report" (GACC, 2016, page 38,) states that in rural areas (which account for 45% of households), 72% of households primarily rely on wood fuel, (and 24% on charcoal). (72% of 45% is 32% of Haiti's 2.2 million households.) Those 700,000 Haitian households (HH) are burning wood as their primary fuel, and their stoves are very inefficient. Many additional homes use wood fires frequently. These households are ideally suited to switch to TLUD woodgas stoves. They would reduce their fuelwood consumption AND would produce about 0.7 to 1.0 kg of charcoal per day per stove in use Selling that by-product (or co-product) charcoal could yield income to those families, and yield about 500,000 kg (500 metric tons) of good-quality charcoal every day, or about 180,000 tons per year. That amount is more than DOUBLE the annual urban consumption (70,000 tons) of charcoal in Haiti's urban areas.

The use of TLUD woodgas stoves in Haiti would reduce the net consumption of primary wood fuel by half, and simultaneously produce charcoal. In typical TLUD stove usage, that charcoal is approximately 800 grams per day per HH, or 30% of the energy value of the primary fuel. In other words, by changing to woodgas TLUD stoves, the wood-burning Haitian rural households (almost one third of Haitian households) could cut their fuel consumption in half AND produce substantial amounts of charcoal for use by the urban households or for other uses. The wood that was being saved could be used by another third of Haitian households while also produce more charcoal. All of this is internal and renewable in Haiti, without importation of fuel.

5. Charcoal production: Traditional methods of charcoal production are grossly inefficient and waste two-thirds of wood's thermal energy while releasing undesirable emissions. Within a few years, all Haitian traditional charcoal production could be converted to TLUD charcoal-making applications

(cookstoves and larger devices) which utilize that heat and still yield valuable charcoal. Larger devices include institutional-size (school and orphanage) stoves, bakery ovens, industrial applications, and water heaters for hospitals, hotels, and industry. The TLUD woodgas technologies actually ***triple*** the useful energy from wood by using the two-thirds that was wasted by current charcoal production practices. A fuel industry can be built in Haiti that brings job creation and reduced dependence on imported fuels.

Traditional production of charcoal is notoriously inefficient, at about 10% yield (by dry weight). But to be conservative, let's use 20% yield in this next calculation. 70,000 tons X 5 would be 350,000 tons of biomass from tens of millions of trees and woody shrubs cut out from the Haitian countryside and inefficiently burned, wasting enormous amounts of thermal energy that literally went up in smoke.

6. Acceptance by stove users: Woodgas stoves are shown to be well accepted when introduced in concentrated numbers (reaching "critical mass" for community support), as seen in the usage of thousands of woodgas stoves in Deganga, India (see www.drtlud.com/deganga2016). The experiences in India should be replicable in numerous areas in Haiti where woody fuels are found (see discussion below).

7. Advantages: In addition to being quite clean-burning and using much less fuel for residential cooking, there are other potential advantages to woodgas TLUD stoves.

a. One is the option to use non-wood fuels, such as abundant agro-residues, maize cobs, pelletized grasses and stems.

b. Also, the charcoal produced can be used as biochar, a soil amendment with potential to increase food production. An intensive pilot study of biochar impact in Haiti could be incorporated into the Canadian-sponsored cookstove efforts. The 2015 PhD thesis of Dr. Roy Beckford (agriculture extension services in Florida) about "anthropedogenesis" (soils created by human activity) in Haiti substantiates these statements. [Abstract found at: http://www.prescottsymposium.org/dissertation-presentations-2015/ (second in the list)]. There is already one biochar project announced in Haiti, by Starfysh Foundation, on La Gonave (See third item at: http://starfysh.org/our-work/agriculture-projects/)

c. Similarly, several aspects of the woodgas stoves lead to reductions of CO2-equivalent emissions. These reductions can be converted into carbon credits that could be claimed by Canada, or be reverted to the efforts in Haiti to make the woodgas stoves be essentially self-supporting (or income earning) once they are in use in the households. Dr. Anderson can provide further information about these options, including database record keeping and methodologies for marketing into communities.

8. Woodgas as complement to LPG: Note that woodgas stoves have their greatest appeal to the poorest of the population that is dispersed in the rural and most remote parts of the country. Therefore, TLUD woodgas stoves are quite complementary to the trend toward LPG stoves that relate best to urban households which are supported by modest incomes and local infrastructures which better enable the fuel supply chain and servicing the LPG stoves.

9. TLUD stove activities: Therefore, it is strongly encouraged that woodgas TLUD cookstoves be included in the Canadian-sponsored efforts in Haiti. The revised Activity Plan needs to include wording to recognize woodgas / TLUD technology as viable candidates for activities. The Preliminary document is deficient in at least two areas:

10 below. Institutional (school and orphanage) cookstoves to include TLUD stoves, and
11 below. TLUD stoves as charcoal producers while also providing clean cooking.

10. Institutional-size TLUD woodgas stoves: Since 2016, there has already been production in Haiti of TLUD stoves for institutional (school and orpahanage) cooking. The NGO FdS (El Fuego del Sol) in Port-au-Prince initiated their production. The stoves are optimized for use of the biomass briquette-fuel that FdS produces from recycled materials in PaP. The stoves (or with some variations) can also use the low-value woody fuels in rural areas. A major factor is the substantial savings in fuel costs compared with existing large cookstoves.

The Preliminary Action Plan (2017, pages 43 and 44) clearly recognizes the need for clean-burning stoves for schools. But it only recognizes LPG as an appropriate stove & fuel combination. Everything that is written in the Preliminary plan can be applied to woodgas and TLUD stoves and fuels, often with advantages to the TLUD stoves over LPG. For example:

a) *"The Haiti Program should … determine which schools are within a suitable radius from a functional or potential LPG refilling station."* This might be functional in some of the urban areas. But certainly, FdS could supply appropriate biomass briquette fuel to numerous schools. Furthermore, what about the schools that are too remote to be included, but are virtually surrounded by sources of woody fuels (trees and shrubs) they are currently burning INefficiently. A school-size TLUD stove would use less fuel and could even become a charcoal production site, bringing some income to the school.

b) *"The Haiti Program will also measure the change in knowledge of students, staff, and faculty about the benefits of a range of clean cooking solutions* [including woodgas]. *As part of the initiative, students would be exposed to a range of cleaner and more efficient household cooking solutions, such as ethanol-burning cookstoves and briquettes,* [and LPG] *by linking the schools with suppliers and hosting demonstration days."* Yes, the students would have hands-on learning about woodgas clean-burning technology and the TLUD stoves that they could have in their own homes. They could also learn about LPG and alcohol that do not have distribution into their areas, and will remain unavailable for years to come, if ever.

c) *"Many schools could afford the ongoing costs of purchasing LPG but lack the resources to purchase the necessary equipment to convert to LPG. Providing the starter kit will help overcome that barrier."* That statement is the only recognition that the schools would forever be required to purchase LPG. Giving them the equipment is pure marketing to get the schools "hooked" on an imported fossil fuel. A great, wonderful fossil fuel. Almost addictive. And introducing a financial burden. In contrast, a "starter kit" of a TLUD school stove will be almost as clean burning as LPG, much more financially sustainable, potentially earning income via carbon credits, certainly more climate friendly, and eventually available to all schools, not just to *"the largest schools."*

11. TLUD stoves as charcoal producers while also providing clean cooking. In the Preliminary Action Plan's present form, woodgas stoves are notably absent, and certainly are not acknowledged in the single line for "Firewood" in the report's Table 1: Life-Cycle Environmental Impacts of Various Fuels (page 11). An additional line for "Firewood in Gasifier stoves" would be all green (the favorable Low rating) and would point out that woodgas energy should be considered a serious contender to help solve Haiti's difficulties.

Initial support for woodgas/TLUD stove could be modest (appropriate to the tasks of a pilot project to demonstrate what can be accomplished). One possible excellent pilot area could be on La

Gonave island, with approximately 100,000 people in about 22,000 households. Using the Deganga India operational model and verified results (and our project experience there), the following could be reasonable conservative expectations:

a. 10,000 TLUD stoves would cover 45% of households on La Gonave island. This would be the "critical mass" that sustains the financial arrangements (below) and the creation of local employment for project support, and the "Earn while you cook" program for charcoal production and collection and sales (as shown in the Deganga, India pilot project that is now being increased ten-fold). Note that a thin scattering of stoves results in insufficient sector support for fuel supply issues, training, carbon credit financing, maintenance, etc. It is okay to start with small numbers of units, but a steady supply of stoves is needed until critical mass is attained.

b. Production of TLUD stoves in Haiti is possible. Hundreds of Eco Ayiti TLUD stoves (seen at: https://www.youtube.com/watch?v=jrYntoJDmB0) were produced under the direction of Mr. Rene Durocher by a team of Haitian tinsmiths. Industrial production could be by D&E Green. There should also be importation of a few TLUD stove models for comparisons and marketing, including the Champion TLUD-ND (natural draft) stoves from India and the FAABulous TLUD-FA (forced air) stoves from South Africa (Dr. Anderson is an advisor to both projects.) We can expect transition to stove production in Haiti upon success of the pilot project, but there is no need to start by building a new factory.

c. A carbon credit program with 4 credits generated per stove per year could create substantial cashflow annually. Allow 50% of income to provide project support for 7 years (to the users, for stove maintenance, and for carbon credit certification & verification & administration). The remainder per year can be used for project expansion, investment/loan payback if required, and financial assistance (such as health, water and education projects) to the communities that are the TLUD stove users, the origin of the carbon credits.

d. Results include:

1) VERY clean-burning cookstoves (HAP health benefits).

2) Reduction by approximately 50% of wood fuel consumption in wood-burning households, and by over 200% in each household that previously was cooking on traditionally produced charcoal.

3) Protection of larger trees (and animal habitat) because TLUD stoves work very well with segments of branches and shrubs (including clearing of invasive species) and of coconut shells and some agro-refuse stems.

4) Advantages for women (fuel issues, in-home income earning by TLUD cooking).

5) Reduction in CO_2e emissions

6) (Optional, but to be explored). Placement of biochar into soils to increase food production and provide for better nutrition. This includes becoming "carbon negative" because of carbon sequestration.

7) Project-related employment for 20 to 40 people with various skill levels. These should be mainly for people who were previously involved in the traditional production of charcoal.

8) From carbon credit sales, a direct NET financial gain of $100 K to $200 K per year, for seven years, could total over one million dollars. The "owner" of those gains is intended to be one or more Not-For-Profit entities, yet to be determined.

9) Instead of reaching only 45% of the La Gonave households, TLUD woodgas stoves could potentially reach 90%, that being a doubling of all of the above results.

12. Long term: Success in the pilot project could be followed by accelerated efforts to support 100,000 woodgas stoves by the end of 2018. A larger objective is to service 50% (1.1 million) of all Haitian households within a few more years. Related goals include establishment of a renewable-fuel supply chain, significant climate-friendly benefits, and possible soil and food improvements with anthropedogenesis. **The objective is the transformation of Haiti from within.**

13. Timeline:

a. Everything necessary for the pilot project outlined above is already functioning in India.

b. The pilot project could start with as few as 500 imported TLUD stoves (cost of US$25,000) plus some significant funds (maybe $200,000) for the implementation costs (which would also be needed if starting with 10,000 stoves). The small trial is offered for the "peace of mind" of the donors who will see favorable results before releasing the full funding, but a project with 500 stoves cannot sustain the proposed carbon credit and user-support structures.

c. The GACC 2017 "Preliminary Action Plan…" very clearly points out the complexities that engulf major projects, ranging from obtaining Government of Haiti participation to numerous analyses of markets, fuels, etc. The Plan's timeframe of multiple years is cautious (not bold) and shows a preference (perhaps unintentional) for what might be called "status quo" or ICS stoves (stick-burners and charcoal burners) that in Section 2 above are characterized as "Insufficient" cooking solutions.

14. Conclusion and recommendation: I hope that the revisions of the Action Plan will provide some leeway for new efforts that include woodgas TLUD stoves. Please note that the classification of woodgas TLUD stoves in the Modern Advanced Clean Cooking Solutions (MACCS) category is based on scientific testing and results that GACC and ESMAP used in their 2015 evaluation of different stoves and fuels.

The extreme conditions in Haiti need attention that transcends the limits of outmoded solutions that fall short of today's expectations. Woodgas / TLUD stoves are very much a 21st Century, fresh alternative that could truly have success where so many previous efforts have failed. **Please open the avenues for this woodgas TLUD stove opportunity to become a reality for the benefit of Haiti.**

Thank you for considering these proposed improvements to the Action Plan for Haiti.

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Bio-sketch: Paul Anderson retired in 2003 after 30 years of university teaching (geography and mapping) on four continents. He has worked full-time on TLUD woodgas micro-gasification since 2001, and is internationally recognized as "Dr TLUD". His focus is on sustainable, appropriate cookstove solutions for assisting very poor households. He is a co-author of the Deganga (India) case study and the Founder and Executive Director of Juntos Energy Solutions, NFP, which is a nonprofit organization leading the TLUD carbon credits efforts in West Bengal, India. He has global project experience and is available to assist large cookstove projects that could be proposed by substantial agencies. His

multilingual and intercultural expertise and his wide network of contacts could be valuable assets to successful cookstove projects in Haiti.

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