CHAB micro-gasification for 1GtCO_2/yr mitigation-sequestration: A quantitative analysis for practical decentralized low-cost results before 2020

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Introduction

Removal from the atmosphere of one gigaton of carbon dioxide per year (1GtCO_2/yr, equivalent to 273 MtC/yr) is the goal of the Virgin Earth Challenge. This can be accomplished by the production and deployment into the soil of 300 megatons of biochar (allowing for a 10% mobile/volatile fraction). Through quantitative analyses based on socio-economic, cultural, demographic, climatic and biomass variables, and our detailed knowledge of existing low-cost micro-gasification devices and their resultant biochars, we show the possible accomplishment of that goal within ten years, including sustainable sources of necessary feedstocks.

Combined Heat And Biochar (CHAB) systems use diverse renewable biomass fuels to produce thermal energy and biochar. Our focus is on the small and micro-size CHAB units for distinctly cleaner-burning cooking stoves (third world uses) or to replace high value, carbon-positive fossil energy consumed for heating of residences, small businesses, and industrial process heat (affluent world uses). Expenditures for the heat-creating units can be justified in economic and health/environmental terms, with the production of biochar providing additional incentives to make decisions for change.

Methods

Three low cost ranges of technology each contribute substantially to the target of 300 Mt of biochar production,

1. Micro-gasification that produces biochar is mainly a 21st Century development. The TLUD (Top-Lit UpDraft) pyrolytic gasifier cookstoves bring biochar production to residential living and cottage industry in developing countries. Financial and social advantages accrue from clean emissions/health benefits, fuel efficiency with fuel diversity, environmental protection, employment generation, and low production costs ($0 to $1000).
2. For affluent nations, fully automated AVUD–technology biomass furnaces of 150 – 300 K Btu/hr (40 – 90 kW) are designed, tested, and ready for pilot projects for medium-sized buildings or agro-industrial processes. Smaller units for residences are possible, including replacement of thousands of manually tended smoky outdoor wood boilers that do not produce biochar. At $5000 to $25,000 per project, 5- to 10-year ROI, job creation and improved energy security, the necessary investments are attractive, with biochar as a natural co-product.
3. Units costing from $25 K to $500 K will provide powerful heat in cold climates and potentially electricity (CHP&B) for schools, public buildings and industry, mitigating fossil fuel as well as making biochar. In these, the major costs are for the heat application peripherals (boilers, gensets, etc.), not for the heat-generation/biochar-maker units.

To substantiate fuel supply and pre-processing options, data are presented, including an innovative low-cost “Biomass Conversion Facility” to process 100 tons per day into usable biomass fuel.

Discussion and Conclusions

1. Biochar production becomes economically feasible when the value of heat production covers most of the costs.
2. Except in expensive mega-utilities, heat requirements are typically in small quantities and dispersed locations, favoring the use of micro installations.
3. Micro-installations can be relatively inexpensive, widely distributed (with minimal transportation costs), and number in multi-millions.
4. 1GtCO_2/yr of biochar results from the accumulation of biochar from so many decentralized micro-gasification users.