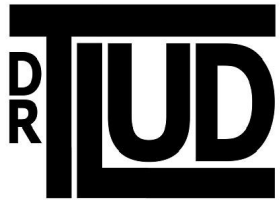


Introduction to Low-Cost Multi-Size PANEL KILNS for Flame Cap Biochar



A Green Carbon Webinar presentation on 28 November 2024

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Specialist in Pyrolysis and
Biochar Production

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<https://woodgas.com>

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New email address specifically
for contact about pyrolysis,
woodgas and biochar topics



Two presentations of similar content:

- **Traditional documents**

- Text (.docx and .pdf) and images
- Ordered in major “Parts” for future expansion
- Accessible “at your own pace”
- Permanence for referencing and additional documents
- Becomes voluminous and can be indexed for referencing
- **Documents** at website

- **Audio-visual**

- Slides (PowerPoint) and video
- Ordered for specific Webinar audience
- **Delivered fast in limited time, but slides can be read separately later for details**
- Revise-able for other audiences and updates
- Becomes easily edited and can be resorted for delivery
- **Recordings & slide decks** also available

EVERYTHING is available at:

panelkiln.woodgas.com

same as woodgas.com/panelkiln

Go to panelkiln.woodgas.com

See Announcement (Level A) information for public release.

The Panel Kiln page is a digital publication with dynamic parts

Structure of the information at the website and in this slide presentation.

Because the Panel Kiln information will be continually growing, the initial and future documents will be separated into FIVE Parts:

Part I: Orientation (Latest updates, reviews, and important overview information.)

Part II: Fundamentals (Review of prior kilns, theoretical topics, patents, IP, and misc.)

Part III: Instructions for Panel Kiln (Definition, fabrication, operation, and details.)

Part IV: Business issues (Three Levels of Support (B, C, D) and income for users.)

Part V: Participation reports (Organized by Support Level, location, theme, and biomass.)

Part VI: Supplementary (References, Appendices, Other)

What are we trying to accomplish?

**Especially because of Climate Change,
the world needs new and better
pyrolysis technology (devices & methods)
for more biochar production at lower costs.**

This is both a Challenge and an Opportunity

You are asked to evaluate and (if interested) to help develop and use

Panel Kilns.

What are we trying to accomplish?

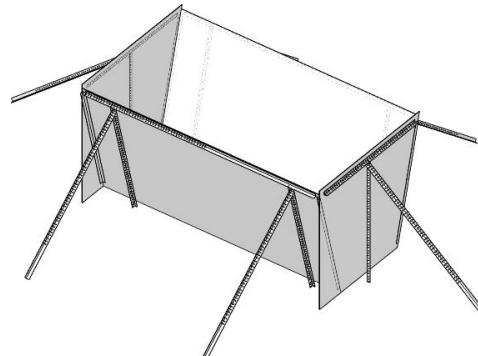
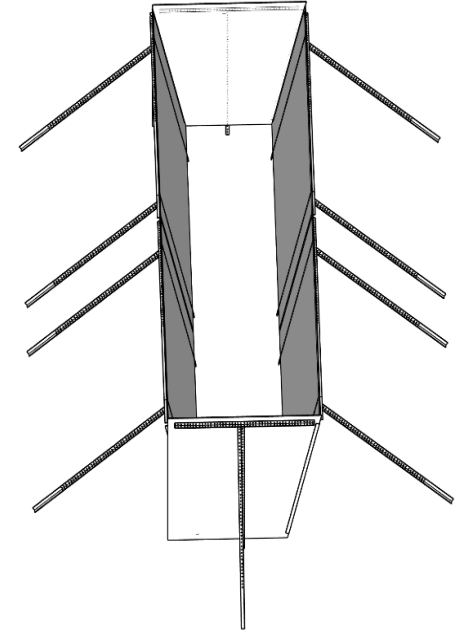
- Because of Climate Change, **the world needs massive amounts of carbon dioxide removal (CDR)**
 - Biochar can be a major tool for CDR.
 - Biochar production technologies have challenges of costs and quantities.
- **Flame Cap (FC)** (a.k.a. Kon Tiki) **pyrolysis is a low-cost technology** for biochar production.
 - FC technology has **limitations** on unit size, production quantities, char-quality control, and mechanization.
 - FC pyrolysis **struggles to be economically viable.**
- **Panel Kiln technology** is presented as **new and better FC pyrolysis** devices & methods.
- **You are asked to evaluate and (if interested) to help develop and use Panel Kilns.**

Definition and First Look at Panel Kiln Technology

From Part III, the Instructions documents

Brief definition of Panel Kiln technology:

- A panel kiln is a set of **essentially modular flat wall segments** that can be transported flat and then **easily positioned with minimal joining to create a six-sided cavity for pyrolysis**.
 - Bottom of earth or separate panel, • Open top (optional)
 - Two sides of one or more segments. • Two ends
- Panel kilns operate with **Flame Cap (FC) pyrolysis** of a progressively top-fed batch of biomass that **accumulates as biochar in a cavity** with no intentional air entering the lower half.



Operational in sizes from **BASIC / Individual kilns (shown)** through **COMMERCIAL and INDUSTRIAL** units with special features for size and biomass types.

Any breakthrough innovation in CDR via biochar requires at least two of the following:

- a. **Significantly lower cost kilns** per tonne of biochar produced.
- b. **Much higher production** per hour or day of operation.
- c. **Significantly easier operations,**
 either manually or semi-mechanized or fully mechanized.
- d. **Maintain or improve clean emissions and biochar qualities.**
- e. **Enhanced mobility** of the kiln to be closer to the source of the biomass.
- f. Prospects for **use of thermal energy** or its safe heat disposal when in fire-prone areas.

The Panel Kiln innovations offer all the above, but not in one package.

Over 20 years of biochar innovations by PSA

- My efforts since May 2001 have been highly focused on pyrolysis, biochar, and related cookstove issues. My credentials include:

Technologies

- **TLUD** (stove and barrel)
- **AVUD** (continuous & automated)
- **Char2Power** (char gasification)
- **Alcohol Stoves** (not pyrolytic)
- **RoCC** (rotatable Flame Cap (FC))
- **Panel Kiln (different FC)**

Support efforts

- **digital MRV** (CERCS CharTrac)
- **Carbon Credits** and Climate
- **AI for pyrolysis** (not revealed)

The prior efforts have brought insights for developing the Panel Kiln innovations.

All the efforts are now being brought together at my website

<https://woodgas.com>

Each effort will have its own “page”

Examples:

TLUD.woodgas.com	woodgas.com/TLUD
RoCC.woodgas.com	woodgas.com/RoCC
Our topic today!!!	
panelkiln.woodgas.com	woodgas.com/panelkiln

Pyrolysis and Biochar Innovations by PSA (cont'd)

- My efforts for over 20 years (since May 2001) have been highly focused on pyrolysis, biochar, and related cookstove issues.

Experiences and Contributions

I have provided 1) much input on Internet discussion groups, 2) participation and leadership at over 20 workshops (5-day stove and CHAB camps), 3) many conferences and webinars, and 4) website content initially at Tom Mile's www.bioenergylists.org/ discussion lists, then at my Dr TLUD website www.drTLUD.com, and in recent years at www.woodgas.com, the location of my 2020 white paper "Climate Intervention with Biochar" and my more complete biosketch.

Methods and Approach

My work is based on principles, theory and operational prototypes for small & medium devices.

I am NOT a manufacturer.

I am NOT an engineer.

My best successes have been when working with others who can engineer and manufacture items.

My past work has been a voluntary donation of time and materials and expenses.

Now larger devices require more funds than personally available.

Therefore, I am presenting a different business approach to Panel Kiln R&D.

Newly revised website: Woodgas.com



- **Woodgas International** is the home of Dr. Paul S. Anderson's work with pyrolysis, biochar and energy, including Woodgas Pyrolytics Inc. and many projects.

Introductory screen shot --- home page

**Focused website / page for mutual
support for Panel Kiln efforts:**
panelkiln.woodgas.com



Introductory screen shot --- home page of
panelkiln.woodgas.com Does it show
access to the four levels of support?
Leads to next slide.

Four Levels of Support are offered.

All aspects are subject to change without notification.

- **A Announcements:** Public awareness. Freely disseminated.
- **B Basic:** Individual and instructional size Panel Kilns. Biochar production **up to 12 t / yr. Free support** to those who register AND **agree to Non-Disclosure to those who are not registered.** Includes basic information and **a discussion group for those who are registered.**
- **C Commercial:** Larger and improved kilns for “serious” biochar production from **12 to 365 t / yr** at one or several locations combined that typically include employees and sales of biochar and/or carbon credit. Has a negotiable \$400 **admission fee, with revenue sharing** when financially successful by using Panel Kilns. Includes access to **Level C discussion group.**
- **D Developer:** Industrial effort with **> 1 t / day** biochar production. Includes generalists and also special-topic groups. Negotiable admission with **commitments for R&D** for large, special projects. **Focused attention.**
- **E. Extra:** Special access for Donors and others that are providing support.

Why Registration, Non-Disclosure, and Payments?

- **Registration:** Building a network of those who work on panel kiln technology.
- **Non-Disclosure:** Those who do the work and share knowledge with others deserve some degree of protection from those who lurk, copy, do not share, and worse.
- **Payments:**
 - To **cover the costs** associated with making the information available.
 - Some funds could be used to **stimulate further activities** in more risky situations
 - When a person or entity is making a respectable income / revenue stream by using the Panel Kiln innovation(s), **paying something to the source** of income is not a bad deal.
 - Paul Anderson has never had a net-positive financial return from his pyrolysis/stoves/biochar work in over 20 years.
- **Pledge:** I, Paul Anderson, will invest and/or spend for the advancement of pyrolysis and biochar CDR technologies any incoming funds that exceed the reasonable allowances for justifiable related expenses and a modest income. My objectives are impacts, not incomes. **Fairness for all concerned is a priority.**
- **This pledge also applies to any donations, grants or investments received for Panel Kiln and related efforts.**

Restatement (For reference, as found in the document Part IV.)

Statement about this Approach with Levels of Support by Paul Anderson:

My approach is chosen because:

- 1) the advancement of Panel Kilns needs (and deserves) more support than what I can provide myself,
- 2) many people in developed (affluent) countries can pay appropriately for COMMERCIAL (C) mid-level or DEVELOPER (D) upper-level access. The less affluent (especially those in less-developed societies) can also have access at BASIC (B) level without payment, and
- 3) there are persons and entities with substantial financial resources (including sponsoring R&D and giving grants) that are encouraged to support coordinated greater efforts of their choice.

My objectives include:

- 1) to invite everyone interested in pyrolysis and biochar supply to join with hands-on efforts with free BASIC (B) LEVEL support materials.
- 2) to bring in funds for my operational COMMERCIAL (C) LEVEL expenses so I can better encourage and reward the collaborative team players at each level and for each issue, and
- 3) to stimulate at DEVELOPER (D) LEVEL the inclusion of Dr. Anderson and his associates in grants, projects, consulting, royalties, R&D, etc. for advanced, larger and further innovation with Panel Kiln use that reaches industrial and national levels, especially in developing societies and challenging situations.

My pledge is to not use more than ten percent (10%) of these funds as personal income, and to use the rest for advancing biochar, especially with those who choose to subscribe / join at the different levels and contribute their time and energy. Our combined efforts are worldwide and include exchanges between societies, crop types, climate zones, economic levels, language groups, etc.

Another Restatement:

Summary Table of Levels of Panel Kiln Support and Key Topics (from Part IV.)

Levels Topics	Public Access ("A")	Basic & Individual (B)	Commercial & Group (C)	Developer & Industry (D)	Owner / Influencer Sponsor / Donor
Objectives	Generate interest	Low-cost initial experiences	Organized use but not full-time	Creating biochar businesses	Organized with multiple businesses
(ROI) Return on Investment	Nothing invested	Learning and personal biochar	Depends on user efforts	With subdivisions for specializations	Significant environment / climate impact & ROI
Cost (Except Level A, all must agree to maintain confidentiality.)	Free	Free to those who register and agree for non-disclosure until released by the PK project.	\$400 (w/ possible reductions) plus 20% of biochar & carbon credits when profitable.	To be determined. Incl. commitment to joint R&D, prototypes, reports and mutual benefits.	Negotiable for investments or territory licenses and/or distinct biomass types.
Confidentiality	Open access to public	Open Access to Level B members	NON-disclosure to others.	NON-disclosure & special agreements	Corporate confidential
Expected participation	None	Please share your experiences to Level B users	Expected to report findings to Level C users	Required to inform Panel Kiln business admin.	Full participation as owner or according to license.
Mailings & List	None. Only the public postings	Occasional as appropriate	Level C Group support	Inner circle info w/ specialized users	Full access
Designs	Only conceptual and as disclosed in further public messages.	Start with a few designs	Many designs with user inputs	Advanced designs & more features give large capacities. 1) Batch focus, 2) Mechanical assistance, stronger fabrication and R&D to handle massive biomass supplies (patents)	We are establishing worldwide use of affordable pyrolysis for CDR via biochar. Multiple entities with many owners. Expect cooperative associations with goal of impact on climate change
Materials		Simple sheet metal	Discussion of the many options		
Fabrication		No welding	User options		
Size / Scale-up		"Residential"	"Substantial"		
Mobility		Moveable	Possible wheels		
Operations		Manual	Semi-manual		
Emissions		Like Flame Cap	Always improving		
Biomass type(s)		Common refuse	Organized supply		
Carbon Credits		Insufficient volume	Possible with consolidation	Customized kilns	So much to use !!
Energy / Power		Not a focus here	Explore options; initial solutions	A major objective at Level D.	Become a prominent source
				Major attention where appropriate	Part of long-term plan for success

Key Topics in the Support: **Comments** (*Intentionally NOT disclosing details about what is to come.*)
These topics are used to help organize the Support Materials that will be coming in to Subscribers.

10. Admin + Notes	Over time, the guidance will accumulate in this topic.
11. Costs	As low as zero with scrap materials; with basic new materials could be less than US\$200 at a typical American hardware store; and future large systems have unknown cost.
12. Designs / Assembly	Many designs, in two major groups: 1) low-cost batch kilns with much manual labor (Levels B & C mainly, but also D) 2) higher-cost larger kilns with semi-mechanized operations (Levels C & D).
13. Materials	Steel, but possible exceptions. Options for fasteners, etc. differ between countries.
14. Fabrication	From simple DIY without welding to full industrial fabrication and installation.
15. Size / Scale-up	Start small, and know that medium, large and mega-installations are possible. Yes, they become more complex, costly, and business-focused.
16. Mobility	All options possible but cost more money corresponding to the size of installation. Mobility via wheeled structures is a topic in Level C support materials.
17. Operations	Manual operation when small, but automated operations can be achieved when large.
18. Emissions	Expect same as Flame Cap, but with improvements for larger, advanced units.
19. Biomass types	All that Flame Cap kilns can do, plus others when additional features are added.
20. Carbon Credits	True CDR via biochar and can have dMRV for certification. Consolidation possible.
21. Energy / Power	No capture with small units, but both thermal and electric power when large enough.
22. Concepts / Theory	Explanations and advanced topics.
23. Other topics (?)	To be added when appropriate.

Orientation / Guide to Panel Kiln Information

There are several interrelated subdivisions for organizing the Panel Kiln information

Levels of Support: Set by subscription; this controls the levels of access for all content.

A is "Announced" as public info. **B is "Basic"** is free C is "Commercial" with a fee. D is "Developer" by private agreement. E is "Extra" (being defined)

Parts:	with	Sections (Sec.) (partial listing and subject to changes)
Part I: Orientation		1. Overview info 2. Latest updates, 3. Reviews, 4. Situations
Part II: Fundamentals		1. Prior kilns, 2. Theory, 3. Patents & IP, 4. Misc.
Part III: Instructions		1. Orientation, 2. Fabrication, 3. Use/Operation 4. Other
Part IV: Business		1. Levels of Support, 2. Income, 3. Carbon Credits
Part V: Participation		To be decided by Support Level, Location, Theme, Biomass
Part VI: Supplementary		References, Appendices, Other

(Red indicates inclusion in the document that is presented.)

Topics:

- 10. Admin & Notes
- 11. Costs
- 12. Designs**
- 13. Materials**
- 14. Fabrication / Assembly
- 15. Size / Scale-up
- 16. Mobility
- 17. Operations
- 18. Emissions
- 19. Biomass types
- 20. Carbon Credits
- 21. Energy / Power
- 22. Concepts / theory
- 23. Other topics (?)

Prior art of low-cost Flame Cap pyrolysis kilns

(From Level A: Part II. Fundamentals, where discussions and references are provided.)



- **1. Structural-bottom kilns:** Being chambers or cavities with fire, all constructed kilns have a non-combustible bottom and walls that are typically sheet steel or ceramic materials. When joined together **they create three-dimensional rigid cavities**, thereby losing their “flat panel” nature. Loss of mobility and with increased cost of kilns.

Two main types, each with variations:

A. Cylindrical: Kon Tiki (Above)

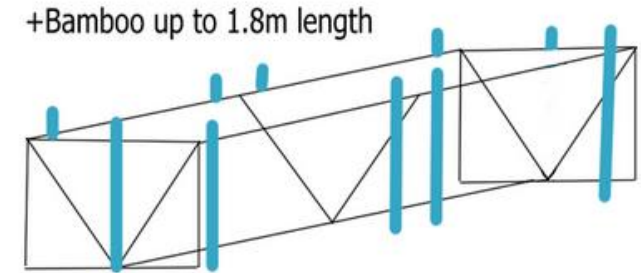
B. Box-shaped: Trough (Below and on right)



Prior art of low-cost Flame Cap pyrolysis kilns

(From Part II. Fundamentals, where discussions and references are provided.)

- **2. Earth-bottom kilns** are of two main types:
 - a. Some are **entirely in the earth, such as dirt-walled pits and trenches** that are essentially empty holes that cannot be moved.
 - b. Other designs have **walls above ground level** that either simply sit upon the earth or are walls that project upward **above the side of a usually shallow hole or pit or trench**. If desired, a loose sheet of metal can be at the bottom for purposes of soil protection and/or easier collection of the created biochar.



Images are of units by H-P. Schmidt, K. Wilson, G. Gilmore and 2 by J. Jenkinson.

These walls are almost always curved or trapezoid-shape and welded or bolted together. Our stricter definition of panel kilns refers to being flat, rectangular and basically unattached sheets of steel.

From Part V: Participation Reports

- The **first Panel Kiln project** has been active since January 2024 in **Bungoma, Kenya**.
- Operated by Biochar Pamoja, owned by Gilbert Mwangi.
- **One Panel Kiln** with 2 workers has produced 18 tonnes of DRY biochar from corn stalks (stover) in 10 months working four days per week. **(Could be 30 t/yr)**
- There is much more to report from Kenya to those who register for Level B (Basic) support. Items include:
 - **Video of assembly** of the Panel Kiln in three (3) minutes.
 - Details of **fabrication, including costs** of materials.
 - Notes on **operational issues**.
 - Direct discussion with Gilbert Mwangi.
 - Eventually covering the full list of Topics at right.
- **Free registration at:** www.panelkiln.woodgas.com

Topics

10. Admin & Notes
11. Costs
12. Designs
13. Materials
14. Fabrication / Assembly
15. Size / Scale-up
16. Mobility
17. Operations
18. Emissions
19. Biomass types
20. Carbon Credits
21. Energy / Power
22. Concepts / theory
23. Other topics (?)

Opportunities for working on innovations with PSA

Contact psa@woodgas.com

Technologies

- **TLUD** (stove and barrel)
- **AVUD** (continuous & automated)
- **Char2Power** (char gasification)
- **Alcohol Stoves** (not pyrolytic)
- **RoCC** (rotatable Flame Cap (FC))
- **Panel Kiln (different FC)**

Support efforts

- **digital MRV** (CERCS CharTrac)
- **Carbon Credits** and Climate
- **AI for pyrolysis** (not yet revealed)

Consider PSA in your research projects & grants.

Something NEW with **larger TLUDs**. Needs Level D investment of \$200 K for R&D prototype and field trials for a start-up business.

AVUD **residential heating in modern homes** with thermostat control using pellet fuel & making biochar. Level D with an investor of \$200 K for R&D prototype & then launching a separate business. Ideal for a manufacturer of pellet stoves or HVAC business.

C2P **consumes** biochar to **run IC engines** for gensets & equipment.

Panel Kilns to solve major biomass problems; 1st small prototypes, then scaling up to become industrial / national projects.

Field burning of straw (rice, wheat, etc.) & other crop residue (cotton, corn, coffee, etc.)

Pyrolysis of **underbrush, forest thinning, orchards, invasives**.

Specific cases for locations, biomass types or objectives.

Example: **palm oil industry** (fronds, EFB, and trunks)

Use of heat from larger innovative “box kilns” automated 24/7.

Special case of **AI for pyrolysis**. Services on contracted basis. General case of AI for many fields: \$500 K for % of new AI business.

There is also a high-tech pyrolysis innovation.

(Edited from Part I.)

In addition to the rather “low-tech” Panel Kiln innovation, I also have a **high-tech innovation** for biochar production. It is **still confidential, probably patentable, and will require substantial funding** to *develop this innovation with capabilities of 24/7 continuous operation, low pre-pyrolysis biomass preparations, use of released thermal energy*, lower costs per thousand tonnes of biochar, several scaled sizes, and more.

It is positioned as a reasonable-cost alternative to the expensive (>US\$ 1 million) rotary kilns and heated auger kilns, but some R&D with smaller size test models should be done before “super-sizing” the design.

This is an **ideal opportunity for an impact donor, impact investor, or innovation-seeking established business** to accomplish a major change in biochar production. Yes, there are risks, but the rewards and urgency for such a solution justify actions.

Anyone with access to funding / resources can contact me privately. Send email to: psa@woodgas.com with Subject: High-tech interest.

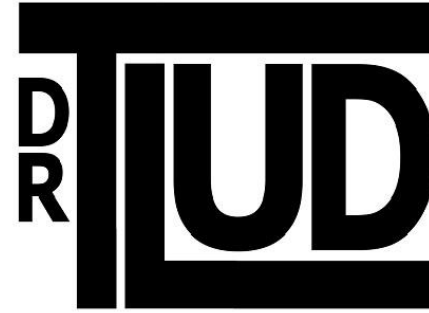
Three major foci to attain large-volume production

- **Low-tech Panel Kiln with much manual labor x many units.**
 - Multitude of individuals with occasional use of very low-cost equipment.
 - Small agro-forestry units; organizational support for wide-spread use.
 - State and national programs of assistance, as in agricultural extension service.
- **Larger / stronger Panel Kilns with significant mechanical support.**
 - Affluent modern farming that has or can obtain mechanical equipment.
 - Cooperatives organized for large tasks.
 - Creation of “service businesses” that contract for the pyrolysis task and funds.
 - State and national programs to solve major issues, such as field burning in India.
- **High-tech macro-kilns w/ 24/7 mechanical automation & heat use.**
 - Organized efforts by sectors of industry (Rice Council, Vineyard Association, Bureau of “etc.”) to include Oil Palm and Forestry.
 - Industrial equipment manufacturer(s) to sell to large end-users / biochar producers.

If interested, please contact Paul at: PSA@woodgas.com

Conclusion

- Thank you for your attention.
- In the coming months I will be assisting those who register for the B, C, and D Levels of support.
- Those who register will have advantages that include earlier notification of relevant information.
- Together we will evaluate and develop the Panel Kiln technology.



Woodgas International

Paul S. Anderson, PhD

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NOTE: This new email address is specifically for stove, pyrolysis, woodgas and biochar contact.