

The "H-Frame" Design of RoCC Pyrolytic Kilns

This initial-release document is dated 15 June 2021 and is known to be incomplete. Updates and/or new documents (including content from users) will be available at this website where there are already several documents and videos about the RoCC kiln technology with general (not H-Frame) information..

Paul S. Anderson, PhD

Email: psanders@ilstu.edu

Woodgas Pyrolytics, Inc.

Website: www.woodgas.energy/resources

The RoCC kiln technology is protected by a patent (pending), including the essentials of the H-Frame design. Basic allowances and permissions are explained in this document. RoCC™ is a trademark of Paul Anderson.

Four Sizes of RoCC Kilns (as of June 2021)

[Introductory slide; All of these are pre-H-Frame designs. They are discussed in other presentations.]

23-inch diameter (590 mm), (200 L or 55-gallon Barrel-size kiln) In Kenya, rear viewer (not in the normal operational position.)

100 to 1000 kg/day biomass input



32-inch (800 mm) Diameter x 48-inch (1220 mm) Length unit in India. Front view at right. Rear view below.



Below: 48 inch (122 cm diameter) x 60 inch length. In California, Feb 2020.



Above and below: 72-inch (6-ft, or 1.8 meter) RoCC kiln inside a 20-ft shipping container w/ mechanical rotation



Evolution of the RoCC kiln

- **Flame Cap** (aka Flame Curtain) pyrolysis technology is accomplished in cavities with closed bottoms and **open** tops.
- **"4C kilns"** were **covered** cavity kilns that were not rotatable. [~ 8 made between 2014 and 2019.]
- **Rotatable Covered Cavity (RoCC) kilns from 2019.**

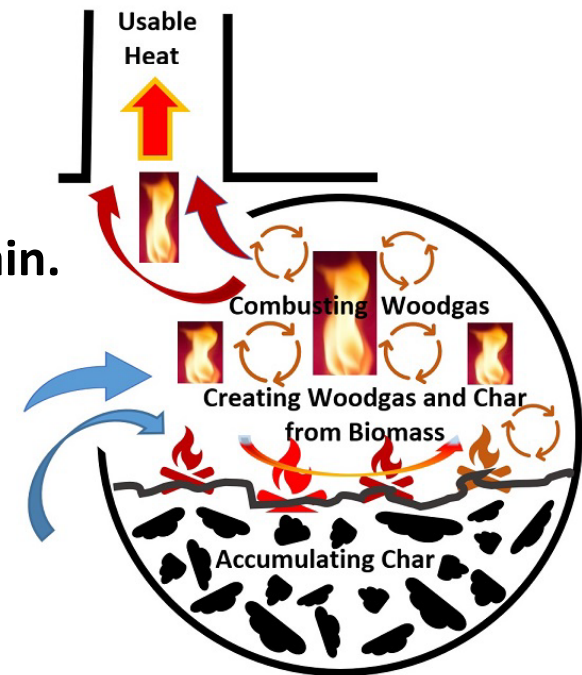
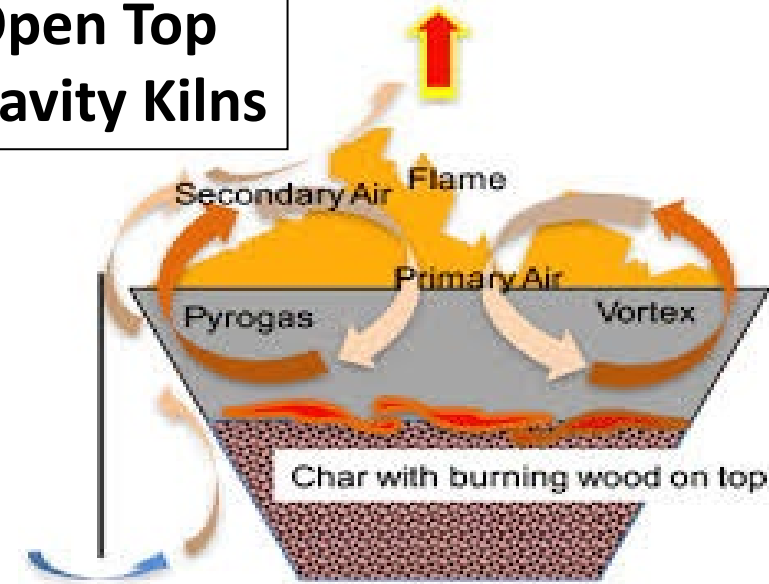
Shared Flame Cap Features

- Heat, flames and emissions rise away from the flame cap.
- Combustion of pyrolytic gases occurs with turbulence.
- Pyrolysis of biomass occurs because of the heat of the cap of flames.
- Char accumulates in the lower areas where oxygen cannot reach because of the cap of flames.

Advantages of RoCC:

- Flame is protected from wind & rain.
- Longer heat retention in the combusting gases.
- Created heat can be directed to uses via chimneys.
- Chimneys can assist with draft.
- Rotation mixes the char to assure that all the biomass is pyrolyzed.
- Rotation to easily empty the char.

Open Top
Cavity Kilns



Covered Cavity Kilns

Summary of Styles and Issues of RoCC Kilns

- **Sizes:**
 - Smallest are in 200 L (55-gallon) barrels.
 - Largest thus far has 6-ft diameter x 7 ft length.
- **Materials (all are metal):**
 - barrels, tanks, corrugated culverts, scrap metal
- **Styles of support for rotation:**
 - On a rack with 4 or more casters / roller wheels holding the cylinder.
 - On rails underneath the cylinder.
 - On axle stubs, with variations named for the shape that supports the axle).
 - Oh-Frame (RoCC n' Roll design) – in the center of the circle
 - X-Frame – at the cross of the X
 - **H-Frame – on the center bar of the H --- This is the recommended design at this time.**
- **Optional features:** Hood with chimneys; mechanized rotation; wheels for mobility; loading and unloading trays;

Latest RoCC Kiln Innovation – "H-Frame"

- Named for the "H" where the axle stub is supported.
- "H" design provided by Paul Wever in May 2021.

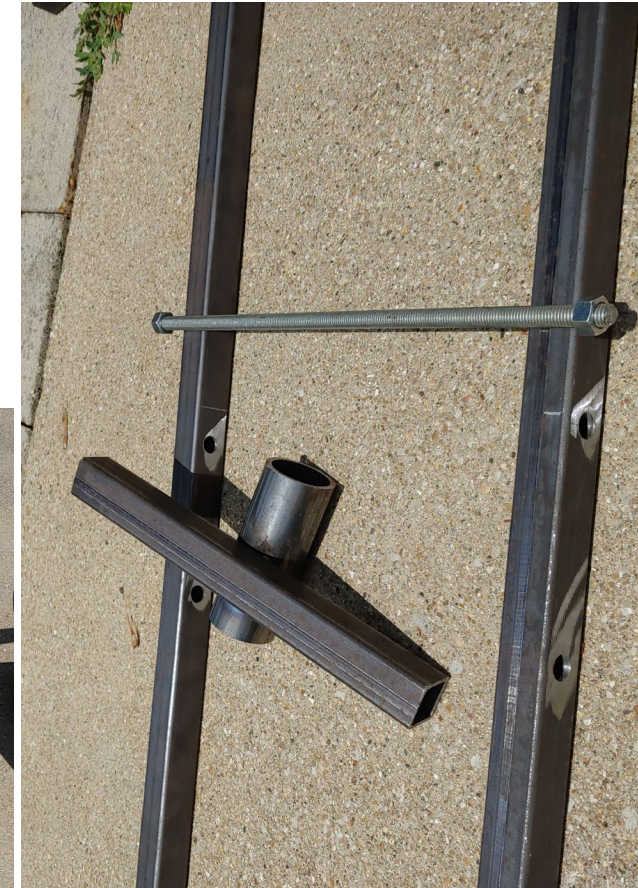


Strong, easy to make, mobile, inexpensive, scalable, welded or bolted, versatile,

Pieces to make an H-Frame RoCC kiln

The cross-bar of the H has adjustable positions ➡➡➡

Wheels are optional, ➡
removable and can be
of various sizes for
different terrain and
height of clearance.



← ← Many
options for the
handles. The
blue ones are
recycled.

Materials list and explanations for ONE full H-Frame barrel RoCC™ kiln 2021-06-03

Notice: RoCC kiln technology (concept, plans, devices and usage) is patented (pending) by Paul S. Anderson, PhD,. Email him at psanders@ilstu.edu concerning options for use for financial gains, including how he can help you increase your income. Further information about RoCC kilns is available at www.woodgas.energy/resources.

Annotated list of materials: (Many variations are possible; contact Dr. Anderson)

[Sorry that the measurements are not yet expressed in metric units.]

A. 1 x 1" square tube cut to lengths for "H" ends and long side pieces.

- | | | | |
|---------|---|----------------------------------|--|
| 1. & 2. | $40 \text{ "} \times 8 = 160 \text{ "}$ | $= 26 \text{ ft } 8 \text{ in.}$ | The vertical supports, two at each end, AND . |
| | | | The horizontal bars, two at each end. |
| 3. | $48 \text{ "} \times 2 = 96 \text{ "}$ | $= 8 \text{ ft}$ | The horizontal bars for the bottom rectangle |
| 4. | $72 \text{ "} \times 2 = 144 \text{ "}$ | $= 12 \text{ ft}$ | To form the "X" brace on one side. |
| 5. | $10 \text{ "} \times 2 = 20 \text{ "}$ | | Each one becomes the horizontal spacer-with-axle-sleeve |

that spans the gap between the two vertical legs of the "H". Onto the spacer, the sleeves (C.2 below) for the axles will be welded (shown in previous slide). This is a separate piece that is the last part to be assembled, with the axles of the barrel in place in the sleeves. Each spacer is held into place by the threaded rod or equivalent through its hollow center and tightened with nuts on the outside of the vertical supports. The position appropriate for a 55-gallon barrel (23-inch diameter) is 16 inches down from the top of the vertical supports. This size of H-Frame can hold up to a 36-inch diameter cylinder that has its axle stubs at the mid-point (20-inch mark) of the vertical legs. Note that if this cross piece is welded into place, the kiln cylinder cannot be removed unless the side braces (A.3 and A.4 are unbolted or cut loose if welded.)

B. Axle stubs for barrel

1. 2 of 1/8th inch steel plate 12 x 12 inches
2. 2 of 1.25" OD pipe 8 inches long Each to be welded vertically in the center of one steel plate. The plates of the assembled (welded) stubs are to be welded to the ends of the barrel.

C. Sleeves made of 1.5-inch diameter pipe that fits over the 1.25" OD pipes of the axle stubs. MAKE SURE that there is comfortable, easy, free rotation of the axle in the sleeves. Wall thickness can be a problem. This is not a snug fit.

1. 2 of 5" long To be welded onto the two horizontal spacers (A.5.)
2. 2 of 4" long To be welded to the handles (D.1.)

D. Handles to be made of common materials that are not too heavy or expensive.

1. 2 of 24" to 30" long These handles can be made of whatever is available.

E. Sliders over 1" sq tube, so probably is 1.25 or 1.5 " square tube (Check the wall thickness to be sure). A useful substitute is 1.25" PERFORATED square tube (to reduce the number of holes to be drilled; See photos.)

1. 6 of 6" long One for each of 6 ends of the 1 x 1" square tube (A.3 & A.4).
(or up to 9" long) These are used to mount the wheels and / or attach the side bars (A.3 and A.4.)

F. Special joiner pieces of rectangular tube through which 1 x 1 sq tube fits easily. Probably 1.5" by 3" rectangular tube, but depends on what sizes are manufactured and available.]

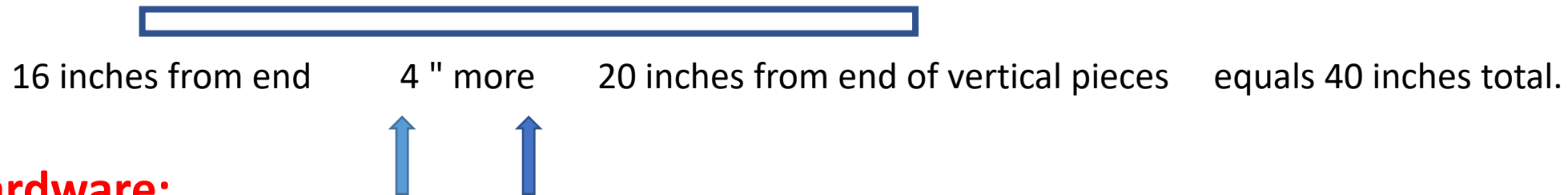
1. 4 of 1.5" wide Can be an offcut / remnant in short pieces.

G. Drilling holes. Most holes are to fit 5/16th inch bolts. Exceptions are the holes for the “H” crosspiece which need to allow the threaded rod or long bolt that holds the horizontal spacer-with-axle-sleeve.

H. Positions of the "H" cross in the 4 vertical pieces of 1" x 1" that measure 40 inches long, drill through opposite sides of the tube at

1. 20 inches from the ends (that is, in the middle of the 40-inch length)
2. Also holes at 16 inches from ONE end on each of the 4 pieces.

Diagram is NOT to scale; and the ends of the tubes are NOT closed.



I. Hardware:

1. Have available nuts and bolts of 3/8 inch diameter, bolts to be mainly 3 inches of threads.
2. Two pieces of 3./8th inch threaded rod, each being about 14 inches long, with nuts and washers as needed. Can be a long bolt or a solid rod that is threaded some at each end.

J. Wheels:

Welded vs. Bolted

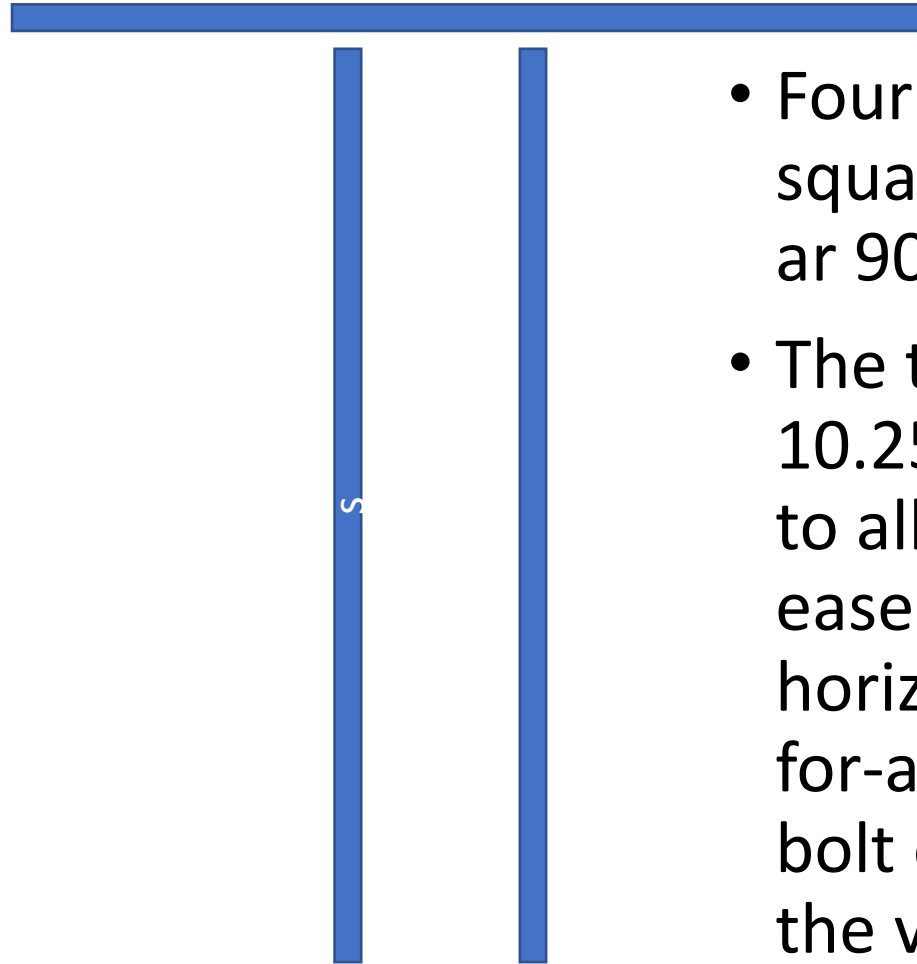
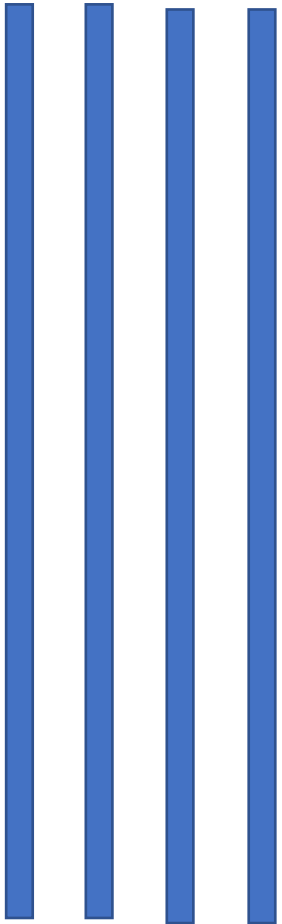
- Welding is faster, less costly, and stronger than bolts with nuts. So weld whenever possible if disassembly is not going to be needed.
- Bolts allow the RoCC kiln to be sufficiently disassembled for ease of shipping and less bulky transportation .
- The two H-shaped ends can be separated from the four side bars (two for the base and two for the side X) to become a very small volume.
- Bolting allows for changes in size, such as when making prototypes.
 - Change the height of the center of the H to accommodate larger diameters.
 - Change the lengths of the four side bars to accommodate longer cylinders.

Adjustable height of the center of the H.



- The matching sets of holes allow for different diameters of cylinders to be used in the same H-Frame.
- The ability to remove the cross piece and sleeve allows for changing the kiln without disassembly of the frame (whether bolted or welded.)
- Note: leave an extra quarter inch between the vertical bars; the bolt will pull the bars together tight to the cross piece.

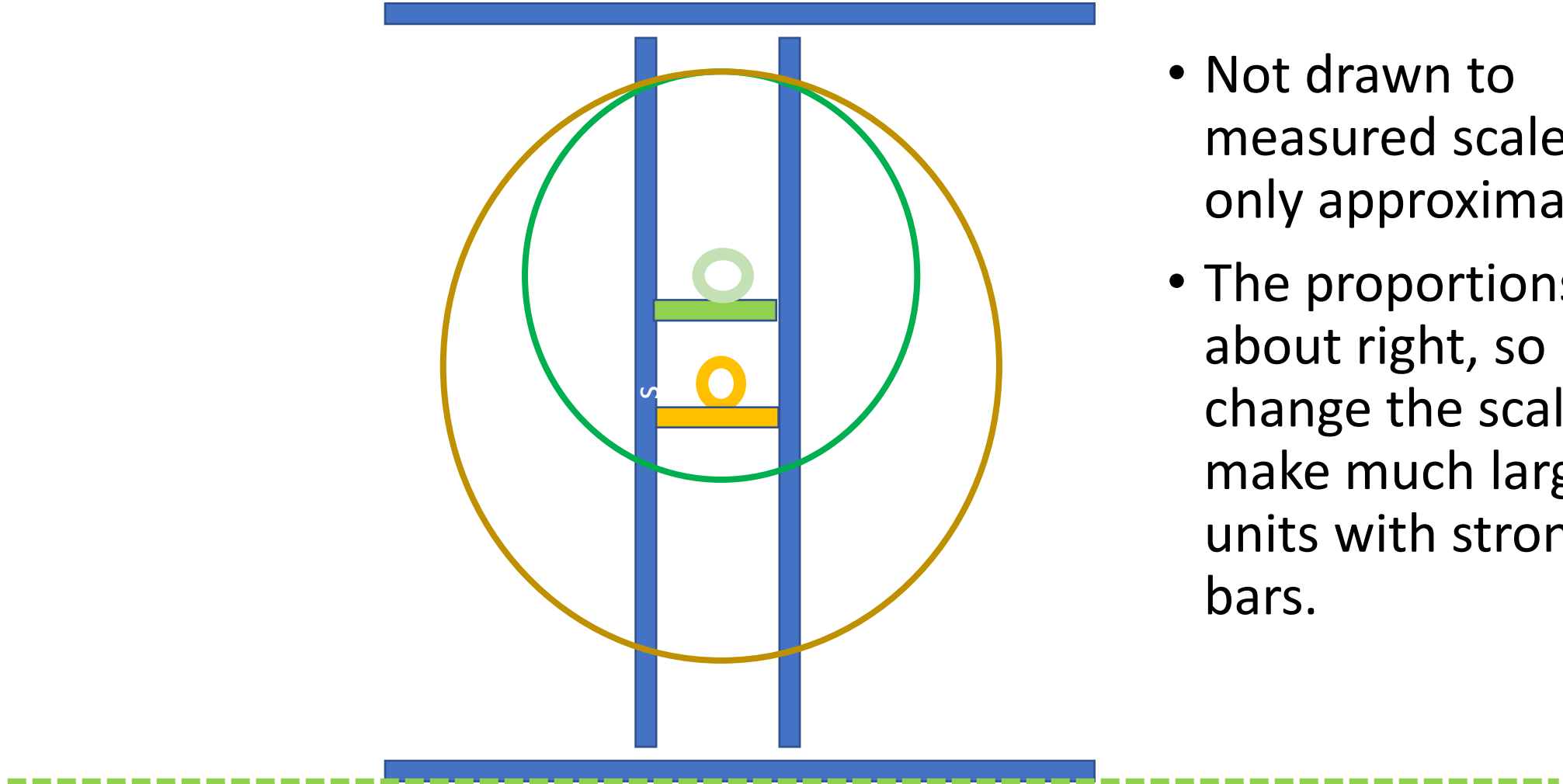
Create the two end pieces ("H" without central piece)



- Four equal pieces of 1" x 1" square tubes 40 " long joined at 90 deg right angles.
- The two vertical bars are 10.25" apart (inside to inside) to allow 0.25" spare for the ease of placement of the 10" horizontal spacer-with-sleeve-for-axle to be secured with a bolt or threaded bar to pull the verticals together.



Showing two versions (green and orange) of the horizontal piece in the "H" design and the corresponding sizes of kiln cylinders



- Not drawn to measured scale, only approximate.
- The proportions are about right, so change the scale to make much larger units with stronger bars.

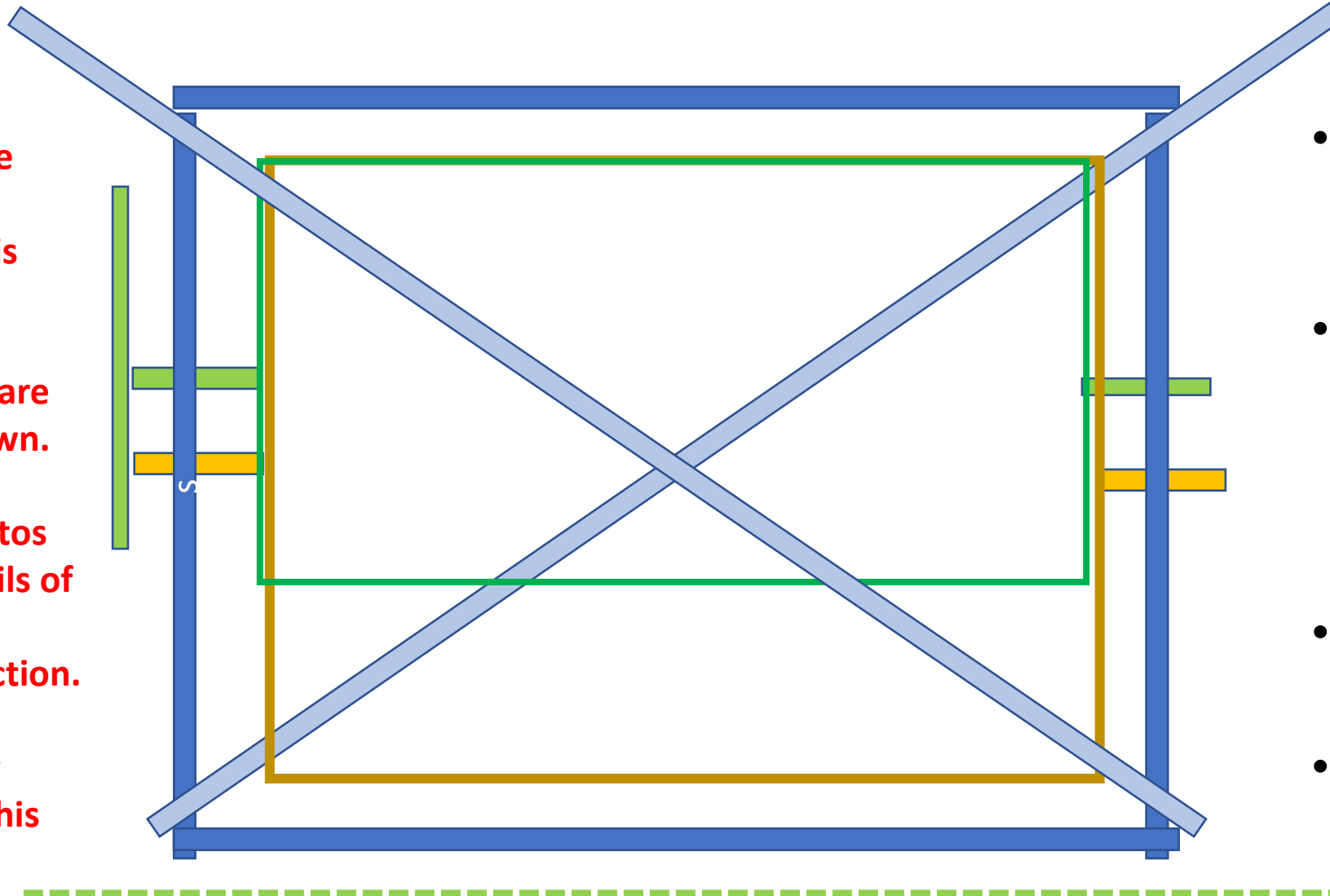
Side view showing two versions (green and orange) of two sizes of kiln cylinders that can fit in the same H-Frame.

Only one handle (green) is shown.

Wheels are not shown.

See photos for details of actual construction.

Welding makes this easy!



- Not drawn to measured scale, only approximate.
- The proportions are about right, so change the scale to make much larger units with stronger bars.
- Length can be much greater than shown.
- There can be many small variations.

Q: What is the big difference between these two H-Frame RoCC kilns on the left?

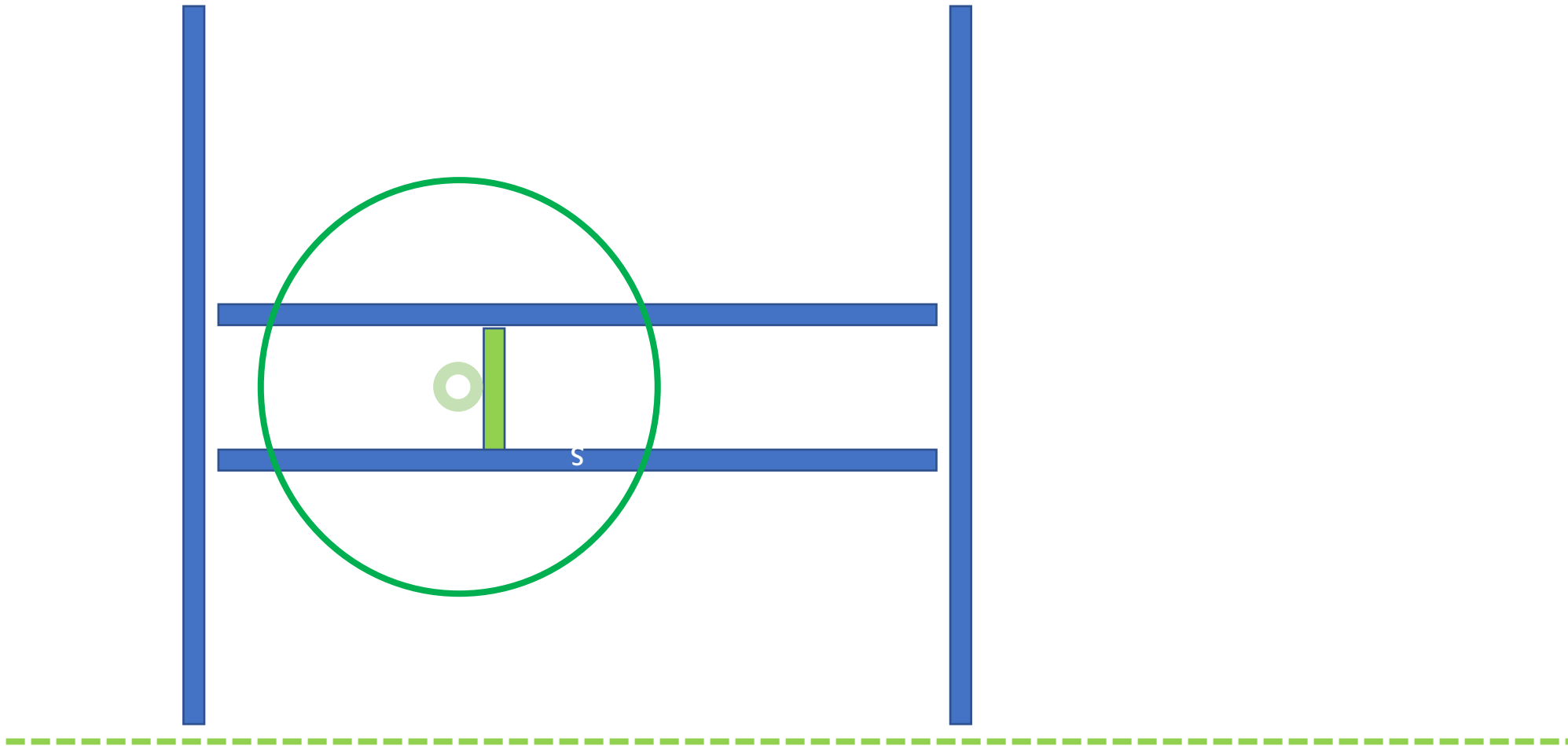
A: Same kiln and frame, but the frame is rotated 90 degrees onto its side.

This changes the height of the portal from the ground for loading different types of biomass.

Both positions can have wheels for moving through fields.



Rotated 90° on its side places the kiln closer to the ground surface if useful for loading.



Photos of H-Frame RoCC kiln (14 June 2021)

This unit can be dismantled with only a wrench and screwdriver so that it can fit easily inside of the vehicle shown in this photo.



Photos of barrel-size RoCC H-Frame kiln

End and side views

- d



One way to attach the sloping tubes of the side-X to the non-sloping H-frames.

Direct welding is easier but does not allow disassembly for transport.



Photos of barrel-size RoCC H-Frame kiln



Patents and Business Prospects

- The RoCC kiln invention has **international patent pending status** with likely coverage until 2040. This protects your interests as well as those of the inventor.
- **When there is financial gain** based on the RoCC kiln production or use or other activities such as gained carbon credits, some modest but appropriate share should come to the inventor.
- Therefore, there are at this time (06/2021) **no up-front fees to become involved with RoCC kilns** and receive expert assistance.
- **All options are open for business arrangements** to be made so that the RoCC technology can become the basis of business for biochar, energy, climate benefits, and more.
- You are encouraged to **become informed** about how you or your geographic area or field of activities could benefit with RoCC kilns.

More information will be coming

- Missing are details about
 - Types of wheels and their attachment
 - Biomass loading shelf
 - Biochar extraction chute
 - Comments on usage
 - Cost and time to build (Under US\$100 in Kenya in one day for barrel size.)
- A Zoom webinar is being planned for discussion of fabrication issues.
- Initial users are encouraged to share their experiences and enhancements.
- Open discussions and announcements are on the "Biochar Crusaders" WhatsApp group and also on the biochar email group. Subscribe at:
main@Biochar.groups.io