Four Connected Biochar Topics about RoCC Kilns, a Kenya Project, (and other places), the CERCS™ App Ecosystem with CharTrac™ and Financing via Carbon Dioxide Removal (CDR)

Presentation by

Dr. Paul Anderson, James Schoner, and Gilbert Mwangi

to the Green Carbon Webinar Series

on 22 July 2021

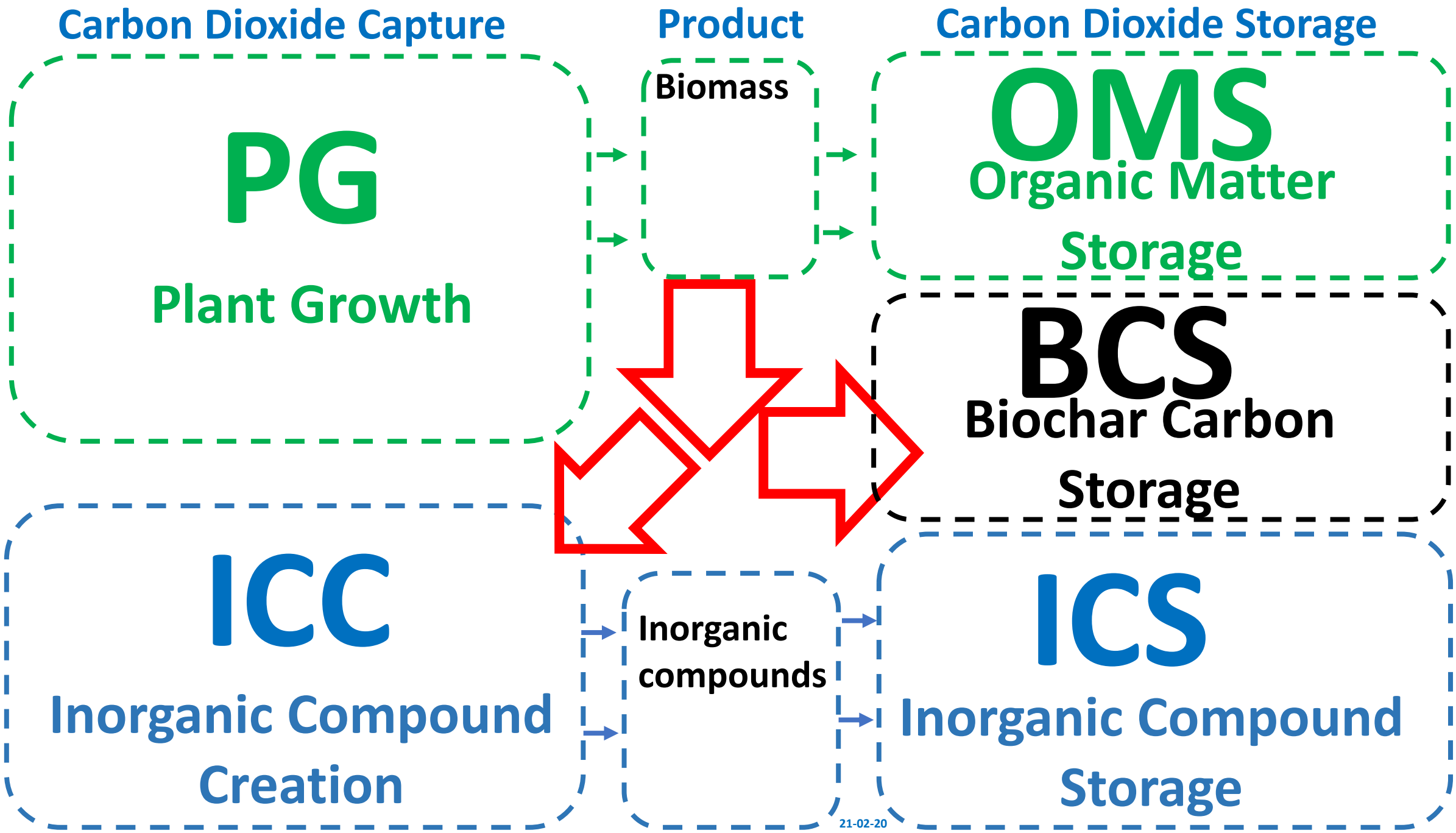
(Recorded to be available on YouTube.)

Contact address: psanders@ilstu.edu

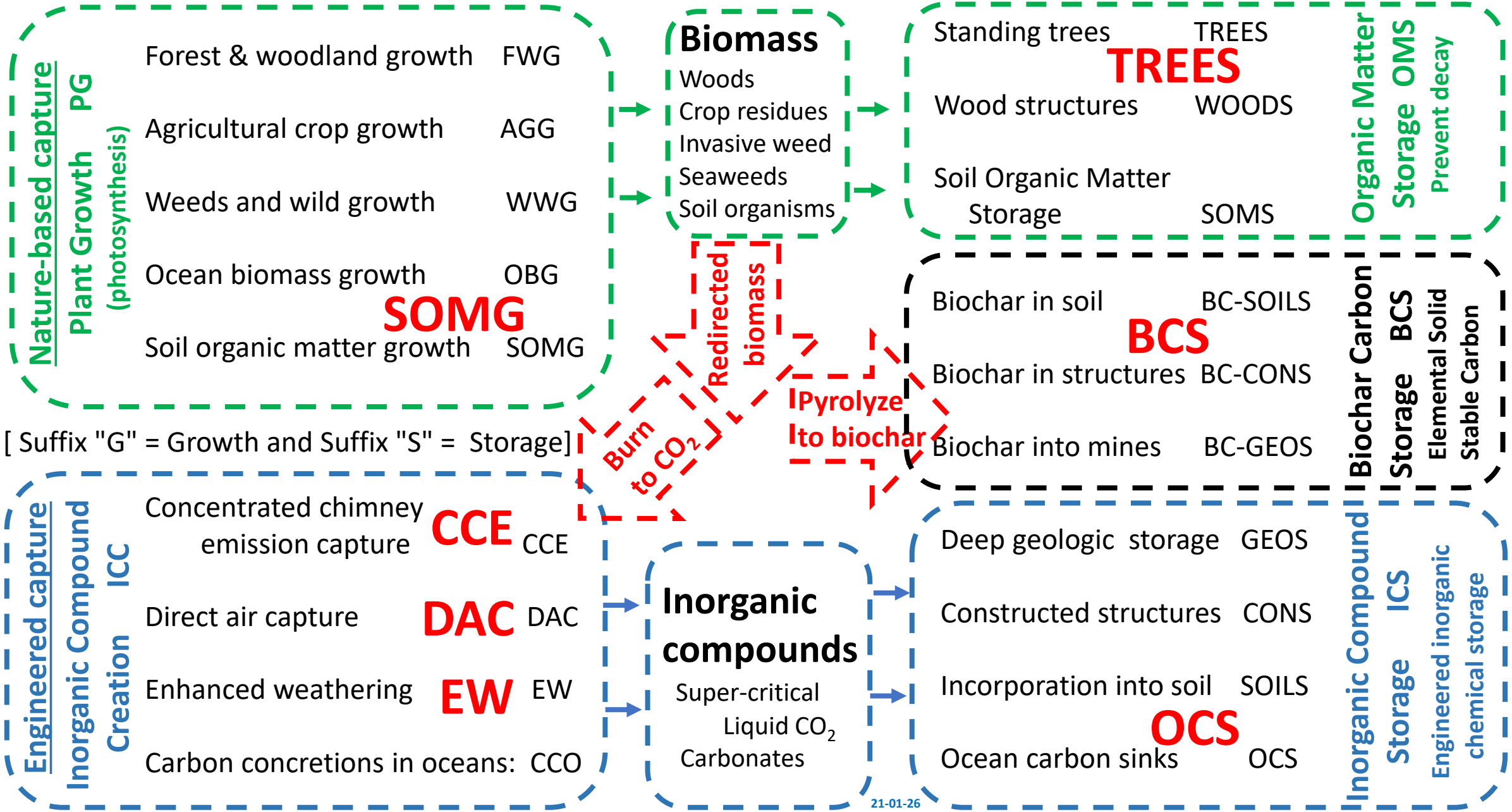
Biochar is in its "Wild Wild West" Stage

- Exciting
- Unknown
- New Technologies
- Dynamic
- Boom and Bust
- Urgency for World Issues
- WEST, as in West Bengal, western Kenya, western world and everywhere.
- Today's presentation is at the frontiers of biochar, so do not expect to receive all the answers.
- But it is also very real, based on years of efforts.

RoCC kilns work well!!


Carbon Dioxide Capture
Product
Carbon Dioxide Storage
PG
Plant Growth
Biomass
OMS
Organic Matter
Storage
BCS
Biochar Carbon
Storage
ICC
Inorganic Compound
Creation
Inorganic
compounds
ICS
Inorganic Compound
Storage
21-02-20

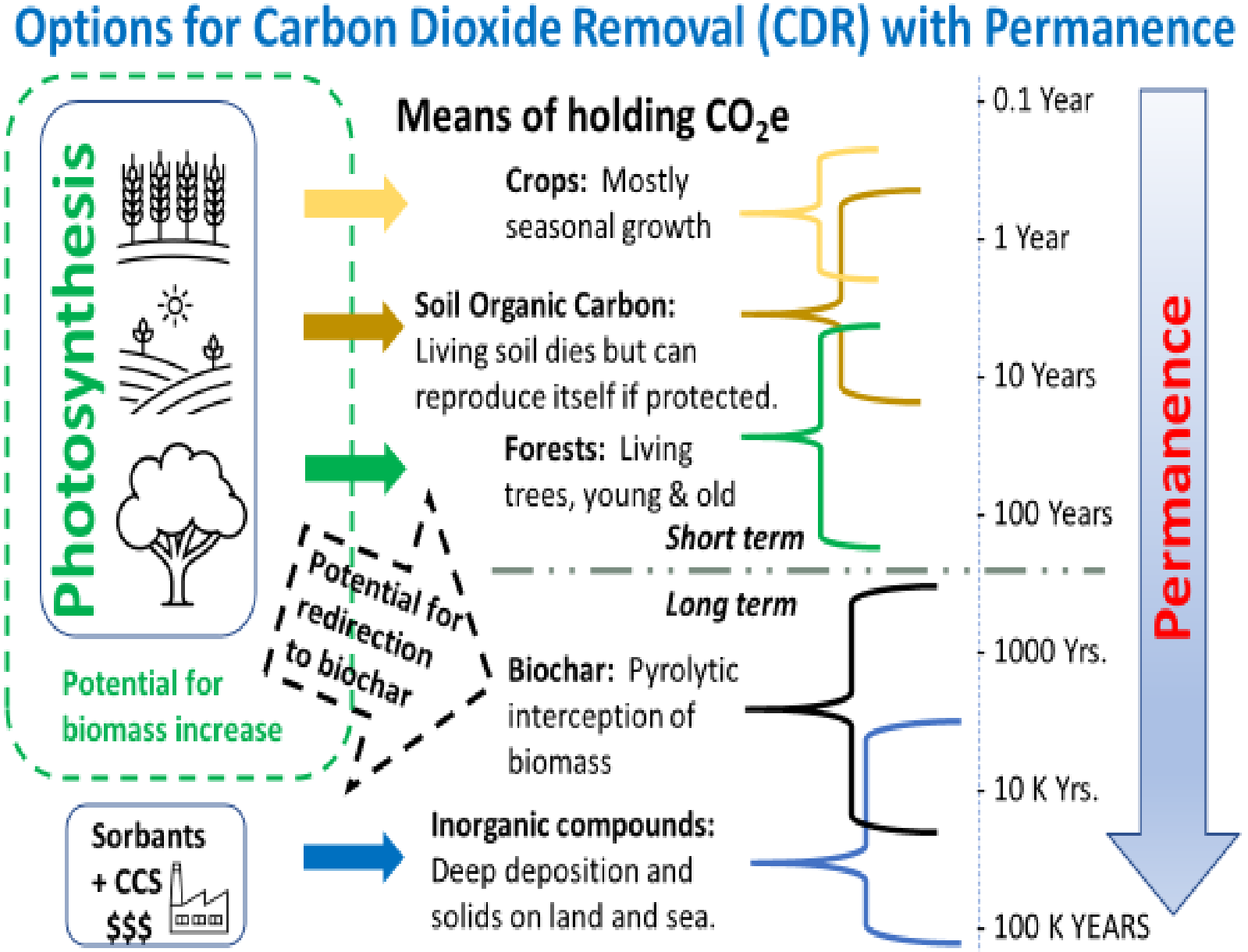
Options for Carbon Dioxide Capture and Storage (= Removal = CDR = GGR)



The objective is CO_2 Removal and Keeping it removed.

Long-term Sequestration

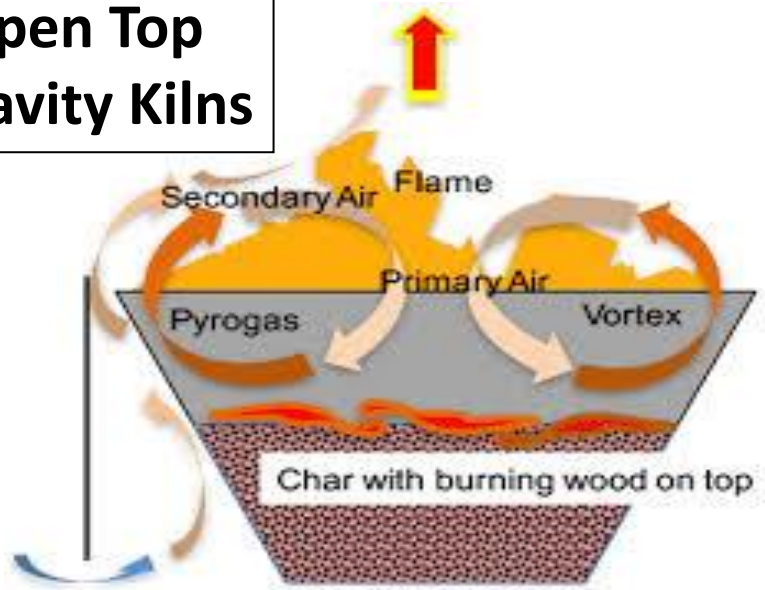
Clear winners are plants with Biochar !



The RoCC Kiln Technology

- **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.**

Open Top Cavity Kilns

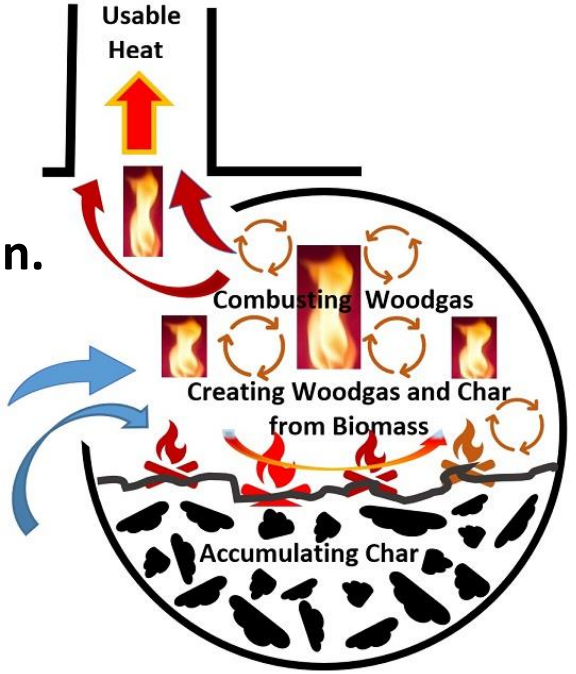


Shared Flame Cap Features

- 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.



Covered Cavity Kilns

Four Sizes of RoCC Kilns (as of July 2021)

Approximate diameters are 2 ft, 3 ft, 4 ft and 6 ft.

[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.)

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.

vv 100 to 1000 kg/day biomass input vv

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

Sizes for Pyrolytic Biochar Production

Classified by Orders of Magnitude of *input of biomass* per 10 hrs of operation

- **Laboratory (< 1 kg)**
- **Micro (1 to 10 kg.)**
- **Small (10 to100 kg)**
- **Midi (100 kg to 1 ton)**
- **Medium (1 t to 10 t)**
- **Large (10 ton to 100 t)**
- **Industrial (> 100 t)**

Objectives

R&D /testing

Cooking

Making Biochar

Various

Char/chem/power

CHP (char secondary)

Major gap in available technology now filled by RoCC kilns

Details are in the Green Carbon Webinar of 25.06.2020.
https://www.youtube.com/watch?v=tdpqx_bzT20

TLUD cookstoves

Different Diameters of **RoCC kilns**

Not my topic

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

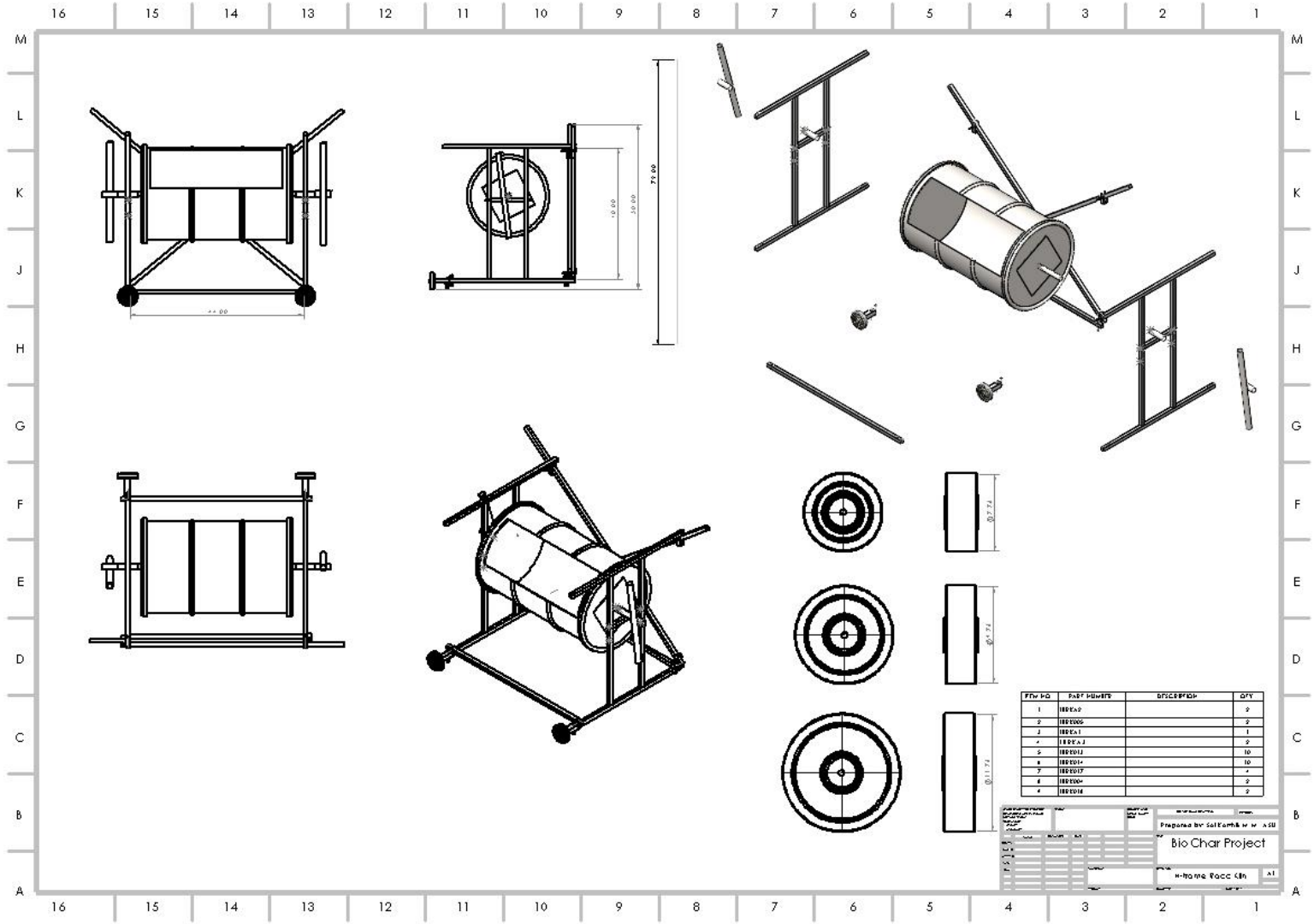
The cross-bar of the H has adjustable positions.

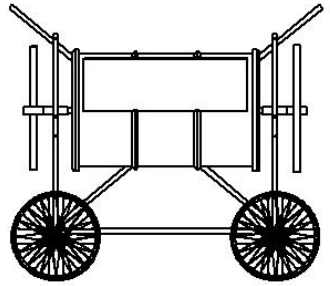
Wheels are optional, removable and can be of various sizes for different terrain and heights.

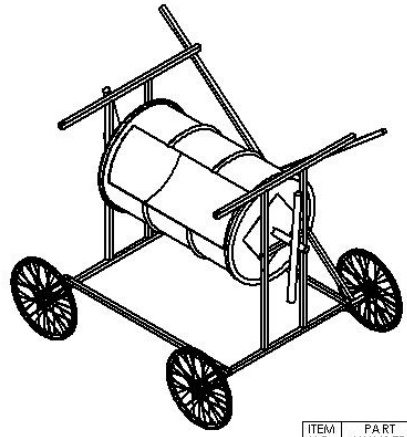
Many options for the handles. The blue pair was borrowed.

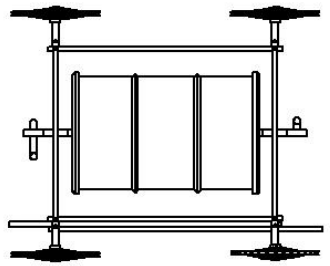
H-Frame RoCC Kiln [Barrel-size]

Drafting by S.K.M.M. at
Arizona State University
2021-07









ITEM NO.	PART NUMBER
1	1BRKA2
2	1BRK005
3	1BRKA1
4	1BRKA3
5	1BRK013
6	1BRK014
7	1BRK019
8	1BRK004

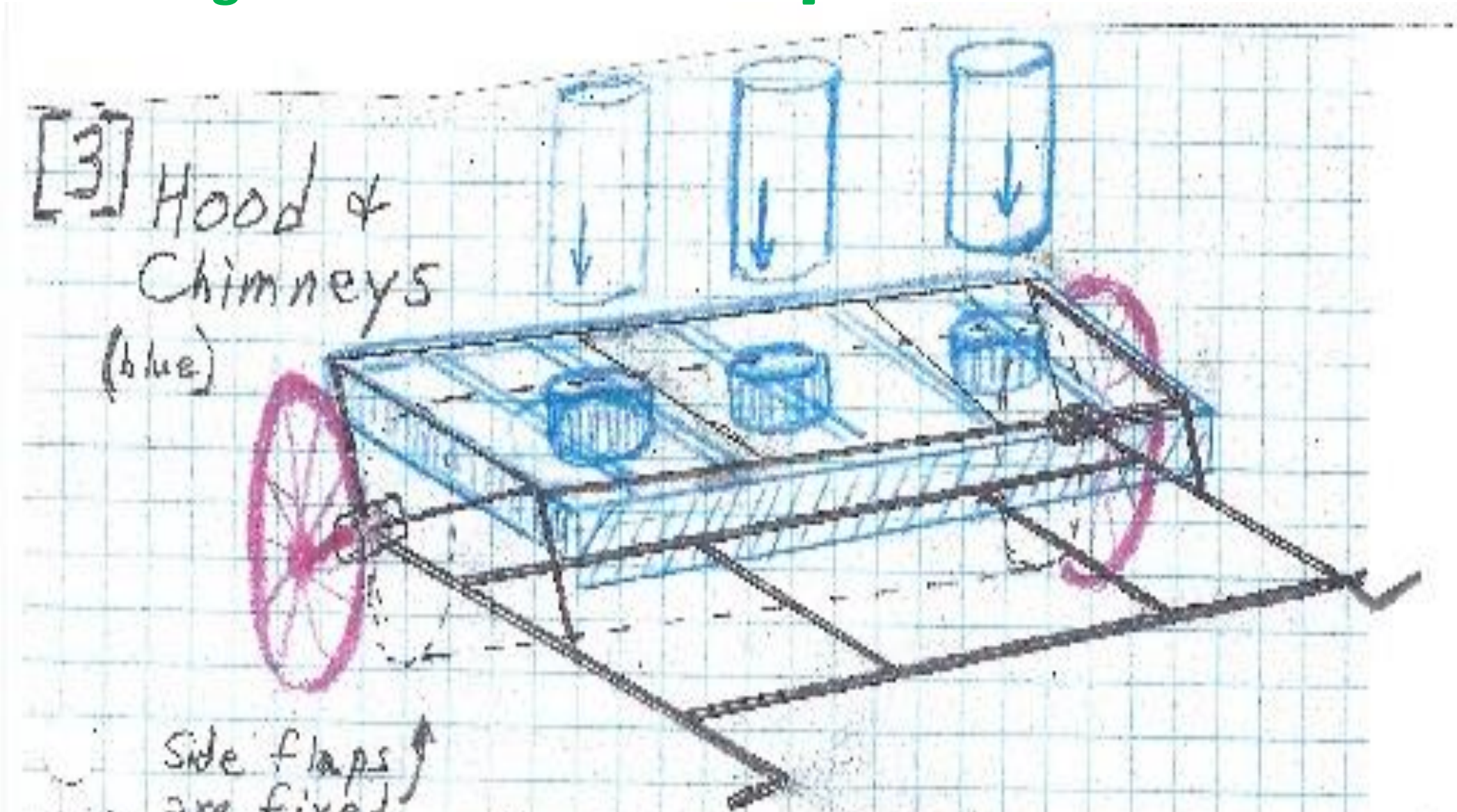
Q: What is the big difference between these two H-Frame RoCC kilns?

A: Same kiln, but the frame is rotated 90 degrees to change the height of the portal from the ground for loading different types of biomass.

Both positions can have wheels for moving through fields.

In-field RoCC Kiln for Crop Refuse (Design only)

[A better design in H-Frame is shown.]



Some Lessons Learned (thus far)

- **No need for door to cover the portal (doorway).**
- **No need for hood and chimneys in most circumstances, but hood and chimney remain an option especially if emissions control or use of heat is desired.**
- **No need for the grate / bars that can swing into place over the portal. The relative cost is high, they can warp, and too hot to actually use.**
- **Scrap works fine. Use scrap materials when possible for great savings.**
- **Learn with mild steel; stainless steel is not necessary when learning and might not be needed for your application.**
- **No insulation.**
- **No protective paint and galvanizing because they do not last.**

Each of the main sizes is presented in the separate project slides later in this presentation.

Documents and videos about RoCC Kilns are available at www.woodgas.energy/resources where is also found the white paper "Climate Intervention with Biochar"

More discussion about RoCC kiln construction and use can be provided after the main presentation is finished.

Three very distinct operations that work closely together in a RoCC kiln Biochar Project

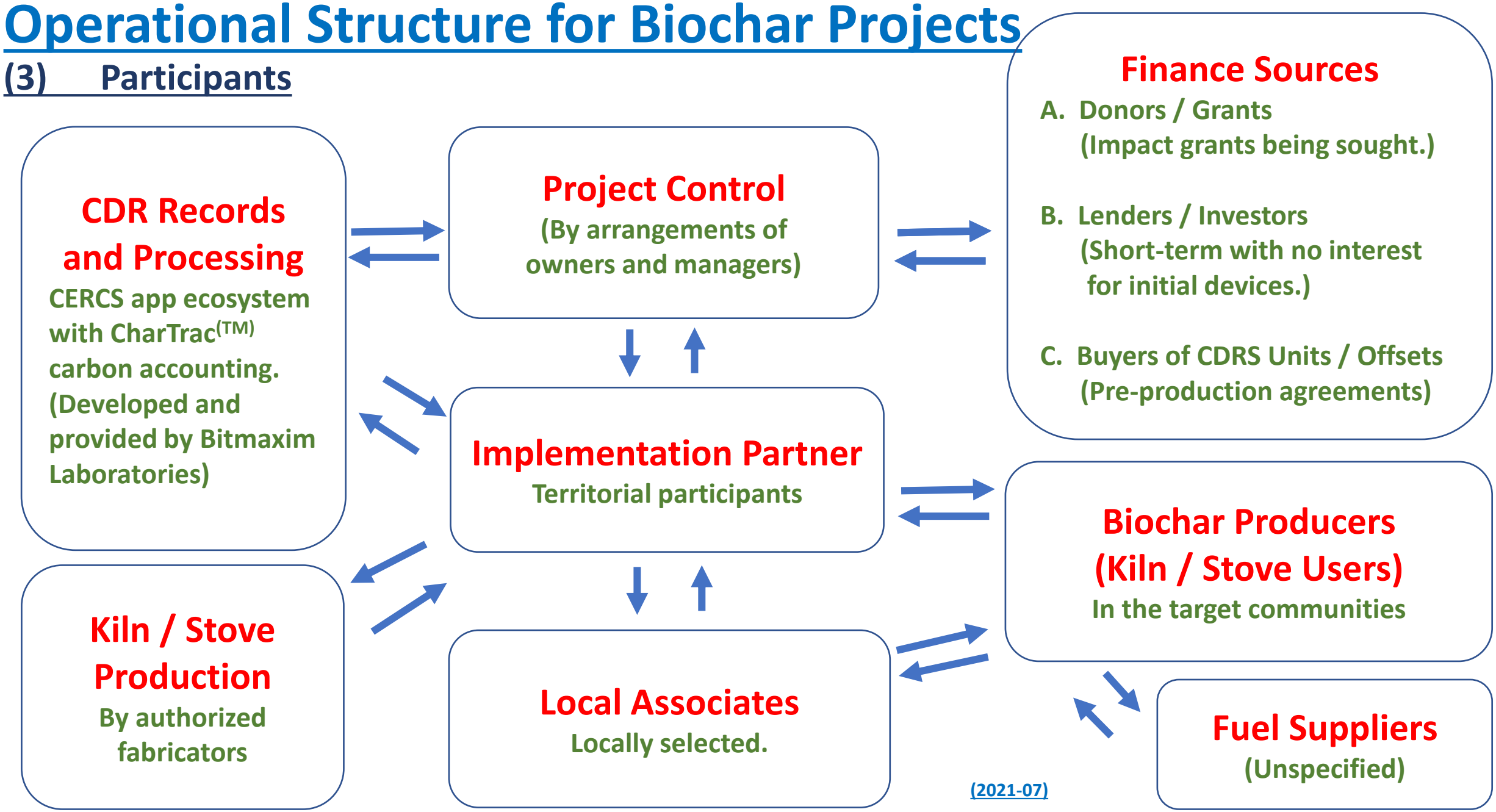
- **Biochar production:**
  - Biomass supply, pyrolysis, documenting, and holding.
  - [Transformation into stable carbon of ~50% of CO_2 that was captured via photosynthesis.]

- **Biochar sequestration into soils:**
  - Preparation, transport, "sinking", and disposition.
  - [Long-term storage that cannot be reversed. Additional benefits should be recognized.]

- **Biochar carbon financing:**
  - Control, measurement, reporting, verification (MRV), certification, marketing, and sales.
  - [Acknowledging value of carbon dioxide removal and storage (CDRS).]

Operational Structure for Biochar Projects

(3) Participants



(2021-07)

CERCS™ App Ecosystem with CharTrac™

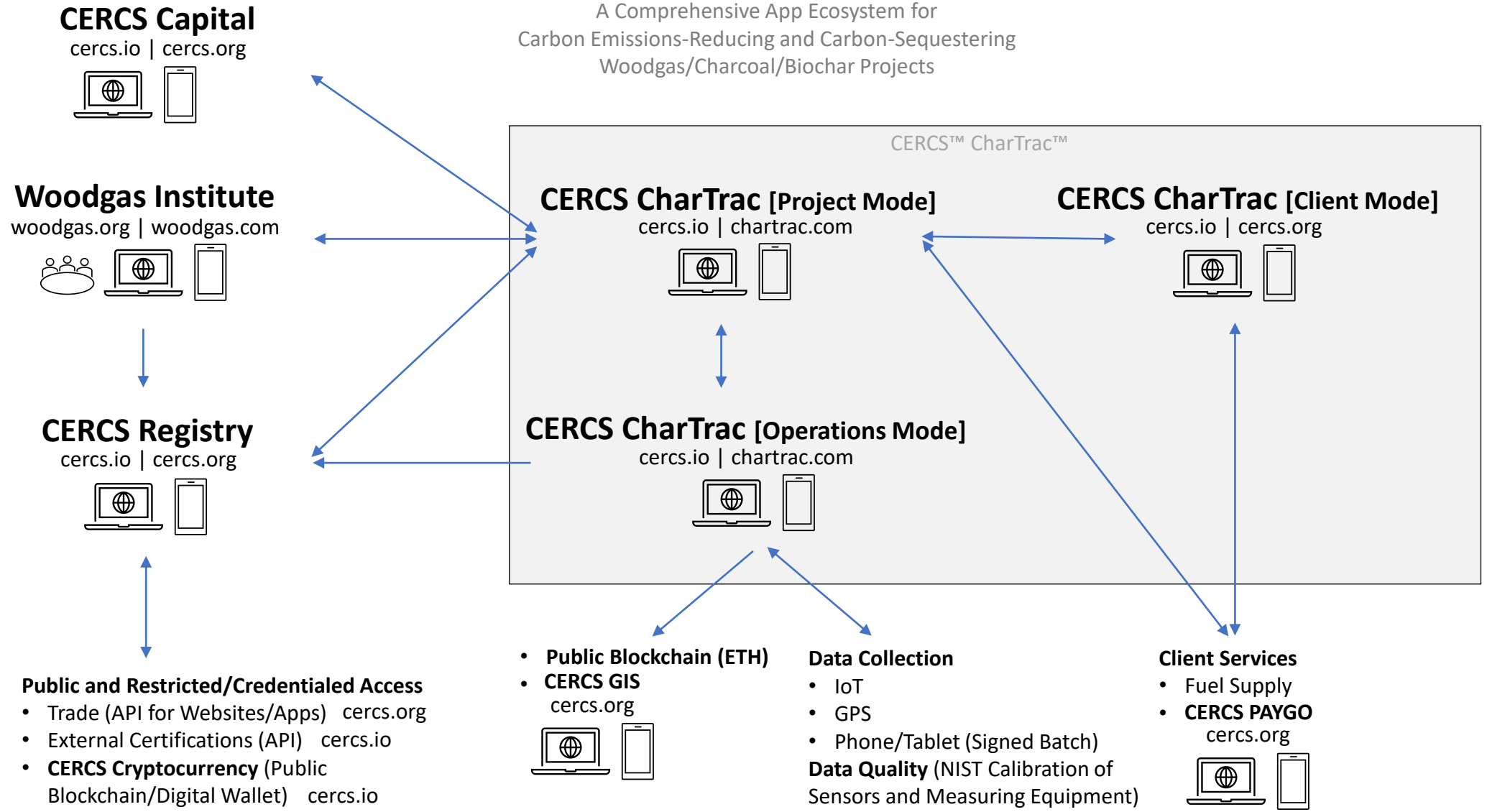
- Climate change is upon us, and **carbon** is at the center of concerns.
- Transactions regarding carbon finance REQUIRE confidence or credible "proof" of actions having taken place and not being reversed.
- **Credibility requires MRV** [measurement, reporting and verification] so that certification can be given, leading to payments.

- The **CERCS app ecosystem** includes a comprehensive expansion of features of the original CharTrac carbon accounting app that was created for a 2018 - 2020 project in Hingalganj, West Bengal, India.
- The CERCS apps and APIs are designed to provide a wide range of services and integration possibilities.

Bitmaxim Laboratories
bitmaxim.com | bitmaxim.io

CERCS

A Comprehensive App Ecosystem for
Carbon Emissions-Reducing and Carbon-Sequestering
Woodgas/Charcoal/Biochar Projects



About CERCS:

Every carbon offset generated by a project is calculated from and linked to a unique subset of field operations data secured by cryptographic hashes ("digital fingerprints") on the blockchain. Thus, **every carbon offset can be traced to specific data** (digitally-signed, timestamped measurements from field operations) for purposes of verification and validation, leading to recognized certification in an official registry.

The **CERCS Registry** delivers important features that support carbon reduction and removal projects of all types (not just biochar and woodgas projects). One of those features enables **aggregating fractional unit claims** so that small or limited contributors (*e.g.*, small producers who periodically make and sequester biochar in small gardens, *etc.*) may have the opportunity to be recognized and rewarded with micro-incentives while contributing to the drawdown of atmospheric carbon dioxide.

All technical inquiries related to CERCS™ and Bitmaxim Laboratories:
James S. Schoner (Director at Bitmaxim Laboratories)
Email: bitmaximlabs@gmail.com

Implementation Scenarios for CDR with Biochar:

Draft 2021-07 Subject to revisions; not for citation.

Project Investments do not include some needed support equipment, etc.

Situational Resource Level of the Project Areas (Financial & Educational)

High

Medium

Low

10	100	1000	10,000	100,000
20 - 40 Large RoCC kilns Forest industry - Quebec	100 – 200 Medium RoCC kilns Environment management - California - OR – Urban zones	500 – 800 > Barrel-size RoCC kilns Biochar production industry - Mexico	5000 – 8000 Barrel-size RoCC kilns Agriculture support - Kenya	100,000 – 150,000 FA-TLUD Fabstoves Residential life - Venezuela 100,000 ND-TLUD Champion stoves Family cooking - India
				250,000 Barrel-size RoCC kilns with occasional users

Each of these seven (7) scenarios can be replicated hundreds of times for making millions of tonnes of biochar.

- The CERCS™ app ecosystem (which includes CharTrac™) from Bitmaxim Laboratories in Champaign, Illinois (USA) is the proposed digital measurement, reporting and validation (MRV) process appropriate for these project sizes.

Number of operational units to produce
100 t biochar per day (or 36,000 t / yr) which is equal to
250 t CO_2 removal (CDR) per day (ratio 1:2.5) or > 90,000 t/yr that becomes
US$ 25,000 per day or ~ $ 9 million per year if valued at $100 per t CO_2e

Agricultural Support: Kenya

- Setting up a business in Kenya with barrel-size RoCC kilns.
- Gilbert Mwangi, the implementation partner, has TLUD-ND experience.
- Five (5) RoCC barrel kilns already in use. One is double-length. All have wheels for in-field movement to the biomass.
- Full procedures that are compatible with the CERCS – CharTrac apps system are being refined.

RoCC X-Frame Kilns

(An option to compare with the H-Frame designs.)

[Note the different types of biomass from fields.]

[On wheels the RoCC kiln is easily moved to the biomass.]

Kenya --- Gilbert Mwangi

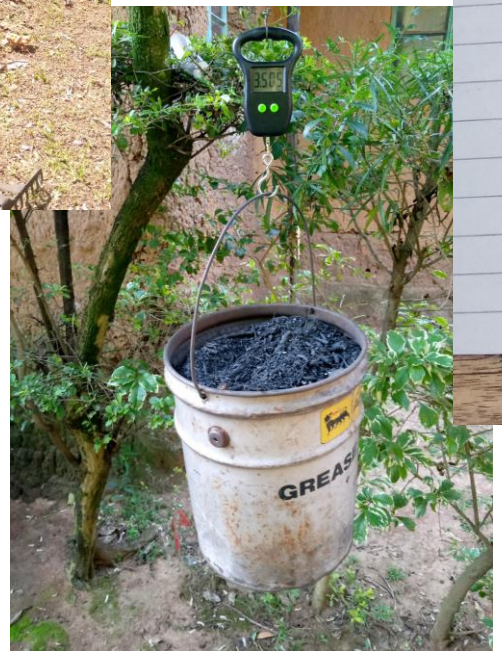
[Success with ricehusk biomass depends on continual feeding in small quantities.]

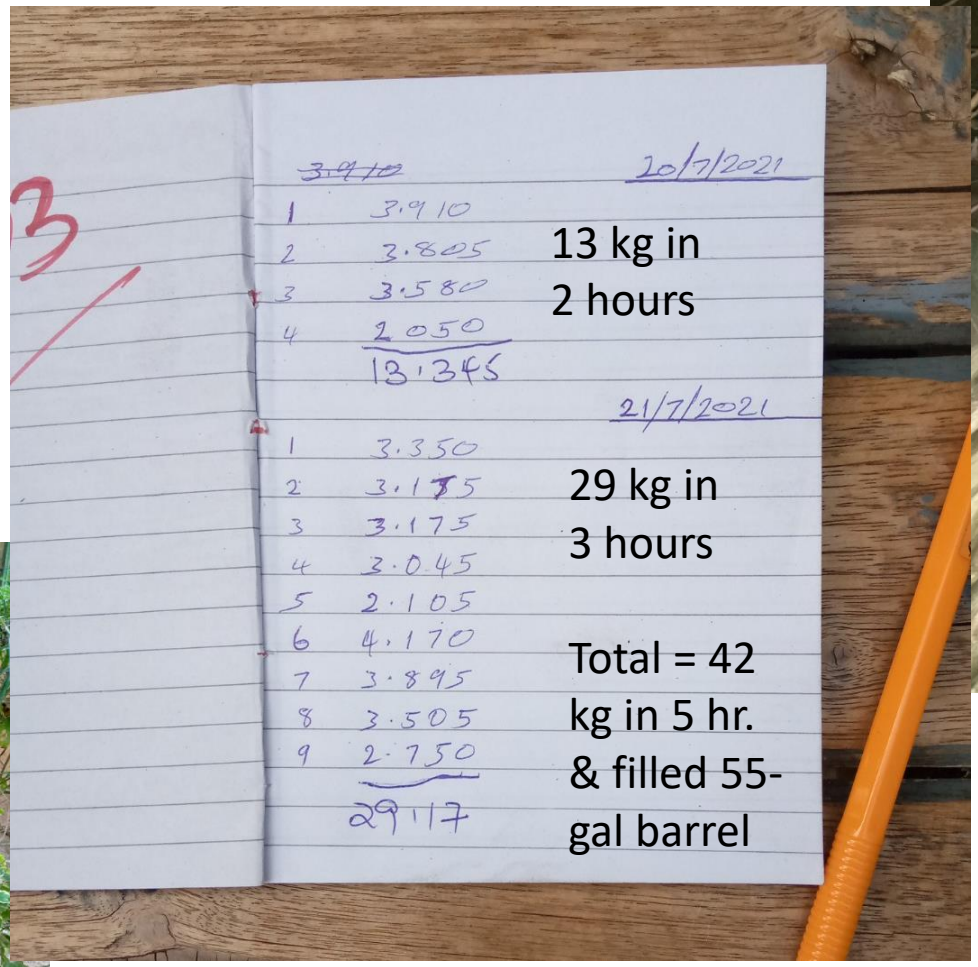
Kenya

[11.6 kg of biochar]

Biochar Production raw data for MRV

Leaf litter / yard waste
Not well dried.





13 kg in
2 hours

29 kg in
3 hours

Total = 42 kg in 5 hr. & filled 55-gal barrel

43 kg= ~ 100 kg CO2e = 10% of one tonne that @ US$!00 /t = $10. Day labor = ~$5

Holding can be in weighed sacks. Eventually mixed into manure or compost and eventually dispersed into gardens and fields

USA ---- R&D by Paul Anderson

One RoCC barrel-size kiln processes approximately 25 kg of woody biomass per hour, or a quarter ton in 10 hours of operation, yielding about 50 kg of biochar.

50 kg of biochar represents approximately 125 kg CO2 long-term removal and storage (CDRS), which is approximately US$12 gross income from sales of CDRS @ $100 per tonne CO2e to companies that are stimulating CDRS (Microsoft, Shopify, etc.).

$6 per day can pay an agricultural worker in many countries.

Operational notes

- **Each RoCC kiln has supporting materials:**
  - A list and explanatory document are being prepared currently with seven (7) items.
    - Scale, 20-liter bucket, 200-liter barrel, numerous sturdy sacks, field tools (pitchfork, shovel, etc.), measuring tape, measuring pitcher, notebook

- **All RoCC kilns are owned and controlled by the Kenyan business** that runs the project with signed agreements concerning RoCC kilns and procedures for data collection, carbon financing with CERCS - CharTrac, and operations.

- **Decentralized, locally-focused implementations** of this business model will enable rapid "scale-up by replication." (Franchise model.)

Industrial production of biochar: Mexico

- Extra-long barrel-diameter RoCC kilns
- Coconut shells
- Biochar for export (20+ tonnes per container)

- Challenges:
  - Loss of control over the destiny of the biochar.
  - Funding

Implementation partner: (Not disclosed) Contact Paul Anderson

Video (30 seconds) of RoCC X-Frame in Mexico with coconut shells

By Kennon Reeves on June 6, 2021

Industrial production of biochar: USA

- RoCC kiln designed for highly specific biomass
- Details are still confidential.

- Opportunity:
  - Seeking $1.5 - $2 million investment

Implementation partner: (Not disclosed) Contact Paul Anderson

Forestry biochar: Quebec

- Forestry "residues"
- Large RoCC kilns
- Current largest is 6 ft diameter x 7 ft length
- Production approaches 1 tonne per day
- Will enlarge to 8' x 20' for logs
- Largest size is not yet known.
- Challenges:
  - Funding. Seeking investor(s)

Implementation partner: Cbiochar, Inc., Dr. Benoit Lambert (forester); +1-450-775-744.

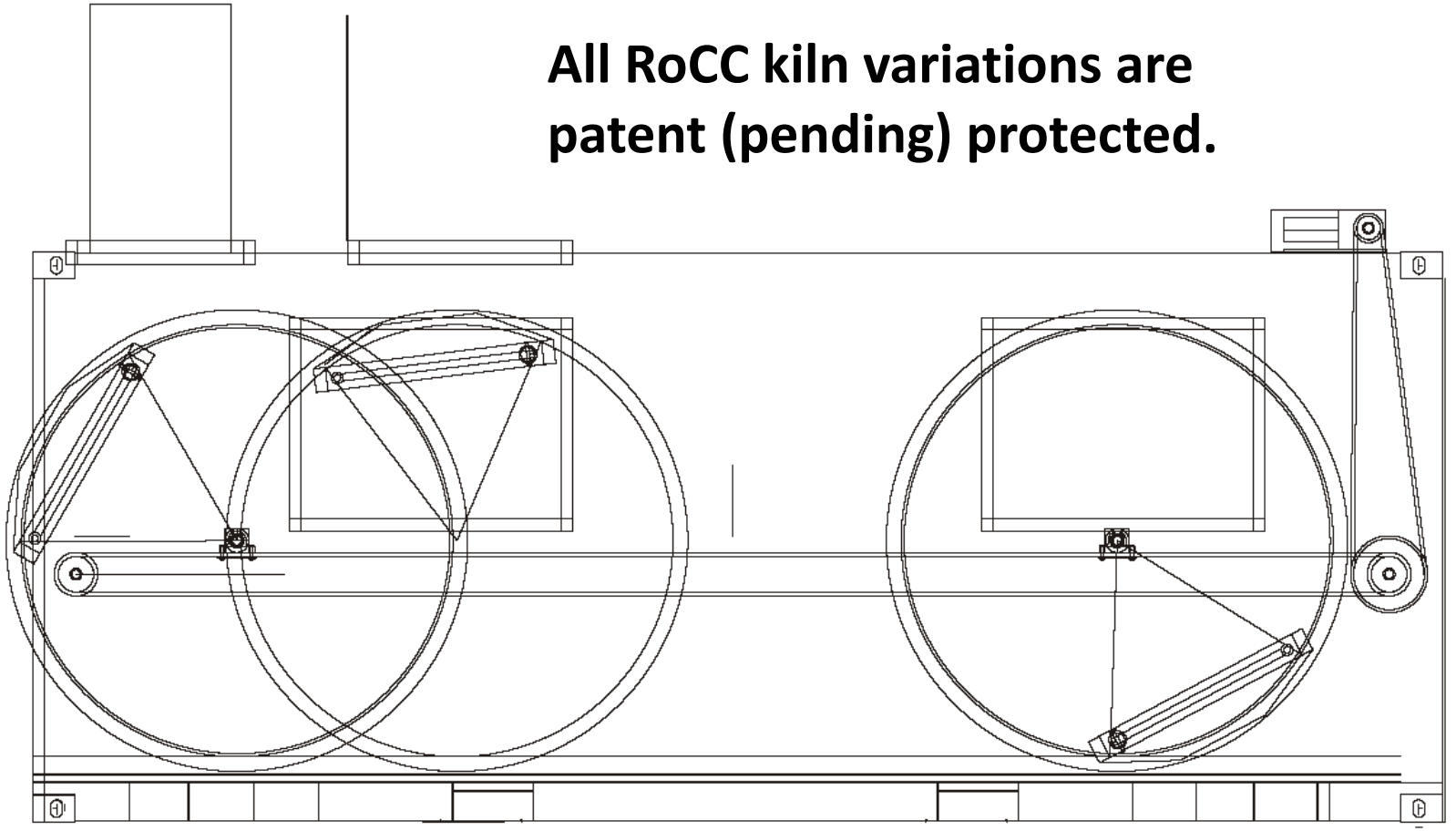
Rails for Rolling

Weight is supported totally on the rails.

The hole in the floor is for dumping the hot char at the discharge end.
N.B. The char is not yet ready to dump in these photos.

RoCC Kiln in Construction: 6 ft D x 7 ft L Inside a 20- ft Shipping Container on rails for rolling

All RoCC kiln variations are patent (pending) protected.



- Constructed in central Illinois with several test runs by July 2021.
- Scale to larger sizes will depend on results and future funding / sales / business associates.
- If interested, write to Paul S. Anderson at: psanders@ilstu.edu

Forestry biochar: Quebec

- 1 "large" RoCC kiln could produce 2 tonnes of biochar per day.
- 2 workers with forestry equipment could operate 2 RoCC kilns, = 4 t/day.
- 25 teams (50 RoCC kilns) could produce 100 t/day, which = 250 t CO_2
- If @ $100 / tonne CO_2e, that is $25,000 or ~$1000 per team /day to cover labor, equipment and support.
- With cleared land and biochar to sell.

Implementation partner: Cbiochar, Inc., Dr. Benoit Lambert (forester); +1-450-775-744.

Environmental management: Fire-prone Western Areas (US) and Urban or Orchard Tree Cuttings

- Medium to large RoCC kilns
- Understory clearing to be pyrolyzed. Hazard reduction.
- Residential safety is priority

- Challenges:
  - Need sponsor(s) with resources
  - Work to minimize emissions
  - **Handle the bureaucracy**
  - Utilize the heat if possible.

Implementation partner(s): Many options; Discuss with Paul Anderson

Personal Pyrolyzer: Occasional Users

- Active people who occasionally make biochar
- Clearing personal property
- Mainly barrel-size (can become a grill).

- Challenges:
  - Comply with local ordinances.
  - Meet minimum biochar production to enter CERCS – CharTrac system or pay fee.
  - Supplier of RoCC kilns or DIY.

Below: Early RoCC kiln by Gary Gilmore, co-inventor.

Implementation partner(s): You. Discuss with Paul Anderson

Table of sizes of RoCC Char makers

(New version 2020-02-15; Draft still in need of refinement; Some rounding)
(Based on cylinders; Extrapolations from Column B; Estimated variability of +/- 50%)

	A	B	C	D	E	F
	Size >>>> Issue (below)	55 gallon (Barrel)	~140 < 180 gallon	464 gallon (4x5 ft) (8 barrels) (1.7 m3)	750 gallon (4x8 ft) (14 barrels)	1500 gallon (~ 20 barrels)
a	Dimensions (Diameter x Length)	(D) 2 x 3 ft = 9 ft3	3 x 4 ft (28 ft3) (210 gal)	4 x 5 ft (62 ft3) (464 gal)	4 x 8 ft = 100 ft3 (2.8 m3)	4 x 16 ft= 200 ft3 (~5.6 m3)
b	Fuel input (kg/hr) (extrapolation from Col B)	~25 kg ~50 lbs (~3 - ~2.5 kg/ft3/hr)	~84 kg/hr	180 - 200 kg/hr	250 – 300 kg (Quarter ton)	500 kg 1000 lbs (Half ton)
c	Char output (kg/hr @ 20% yield) [CO2e reduction per hour]	5 kg 1 wheelbarrow (WB) [18 kg]	~16 kg/hr [58 kg]	40 kg [146 kg]	50 kg [~ 183 kg]	100 kg [366 kg]
d	Thermal energy output as 70% of total (30% in char) 12 MJ/kg/hr 8 BTU/lb/hr	300 MJ 83 kW-h 284 K BTU	Almost 1 M BTU (Under EPA interest threshold)	2400 MJ 666 kW-h 2.3 M BTU	3000 MJ 830 kW-h 2.8 M BTU	6000 MJ 1660 kW-h 5.6 M BTU
e						
f						

	A (repeated)	F (with new units)	G	I	J	K
	Size >>>> Issue (below)	1500-gallon 200 ft3 4x16 ft; 5x10 ftf; 6x7 ft	3000-gallon 400 ft3 11.3 m3	7500-gallon 1000 ft3 28 m3 = 20 ft container	15,000 gal 2000 ft3 56 m3 = 40 ft container	30 K gallon 4000 ft3 113 m3 (RR tank car)
a	Diameter / Length	4 x 6 x 8ft = 200 ft3 (~5.6 m3)	6 x 14 ft or 7 x 10 ft 8 x 8 ft	**8 x 20 ft** 10 x 13 ft 12 x 9 ft	12 x 18 ft 14x 13 ft 16 x 10 ft	10 x 52 ft (RR tank car) 16 x 20 ft
b	Fuel input (estimate per hr) (extrapolation from Col B)	500 kg (Half ton)	1000 kg ~ One ton per hour	2.5 tons per hour	5 tons per hour (~3 - ~2.5 kg/ft3/hr)	~10 tons/hr
c	Char output (w/ 20% yield) [CO2e reduction per hour]	100 kg [0.36 kg]	200 kg/hr [0.73 kg]	500 kg/hr [1.8 t]	1 t/hr [3.6 t]	Estimate 2 tons/hour [7.2 t/hr]
d	Thermal energy output as 70% of total (30% in char) 12 MJ/kg 8 K BTU/lb	6 GJ Gigajoules 1.66 MW-h 5.6 M BTU	12 GJ Gigajoules 3 MW-h 10 M BTU	30 GJ 8 MW-h 28 M BTU	60 GJ 16 MW-h 57M BTU	~120 GJ 33 MW-h 114 M BTU
e						
f						

Selected Sizes of RoCC Char Makers

(**Revised version 2020-06-22**; Draft still in need of refinement; Some rounding)
(Based on cylinders; Extrapolations from Column B; Estimated variability of +/- 50%)

	A	B Midi Scale	D Medium Scale	E Medium Scale	G Large Scale	I Large Scale
1	**Name & Size >>>>**	**Barrel (Home)** **2 D x 3 L (ft)**	**Utility - A** **4 D x 5 L (ft)**	**Utility - B** **4 D x 8 L (ft)**	**Bulk Service** **6 D x 14 L (ft)** **8 D x 8 L (ft)**	**Container (20 -ft)** **8 D x 20 L (ft)** **12 D x 9 L (ft)**
2	**Volume**	9 ft3 = 0.25 m3 (55 gallon)	62 ft3 = 1.7 m3 (464 gallon) (~ 8 barrels)	100 ft3 = 2.8 m3 (750 gallon) (~ 14 barrels)	400 ft3 =11.3 m3 (3000 gallon)	1000 ft3 = 28 m3 (7500 gallon)
3	**Fuel input (kg/hr)** (Extrapolation from Col B) (Based on volume; less if based on horizontal area of flame cap pyrolysis.)	~25 kg ~50 lbs (~3 to ~2.5 kg/ft3/hr)	180 - 200 kg/hr	250 – 300 kg Quarter ton /hr ~ **5 t / workday** or > 2 cords.	1000 kg ~ One ton / hour **~ 10 t / workday**	2.5 t/hr **~ 25 t / workday** (Probably is high, but certainly at least 10 t/ day)
4	**Char output (kg/hr** @ 20% yield) [CO2e reduction per hour]	5 kg ~1 wheelbarrow [18 kg]	40 kg [146 kg]	50 kg [~ 183 kg] (~1.8 tCO2e/day)	200 kg/hr [0.73 t] (~7 tCO2e/day)	500 kg/hr [1.8 t] (~1.8 tCO2e/day)
5	**Thermal energy output** as 70% of total (30% in char) 12 MJ/kg/hr 8 BTU/lb/hr	300 MJ 83 kW-h 284 K BTU	2400 MJ 666 kW-h 2.3 M BTU	3000 MJ 830 kW-h 2.8 M BTU	12 GJ Gigajoules 3 MW-h **10 M BTU**	30 GJ 8 MW-h 28 M BTU

	A	E
1	**Name & Size >>>>**	**Utility - B** **4 D x 8 L (ft)**
2	**Volume**	4 x 8 ft = 100 ft3 (2.8 m3) 750 gallon (~ 14 barrels)
3	**Fuel input (kg/hr)** (Extrapolation from Col B) (Based on volume; less if based on x-sectional area.)	250 – 300 kg **(Quarter ton / hour)**
4	**Char output (kg/hr** @ 20% yield) [CO2e reduction per hour]	50 kg [~ 183 kg]
5	**Thermal energy output** as 70% of total (30% in char) 12 MJ/kg/hr 8 BTU/lb/hr	3000 MJ 830 kW-h 2.8 M BTU

Hypothetical scenario with utility-size RoCC Kiln

- Abundant biomass
  - Slabs / refuse wood; urban wood waste
- Need for heat and hot water
  - Apt complex; school; small industry
- Replace fossil fuel
  - Avoid carbon tax;
- Biochar for agriculture
  - Increasing value
- Carbon sequestration
  - Increasing importance

TLUD-ND Cookstove: Champion (India)

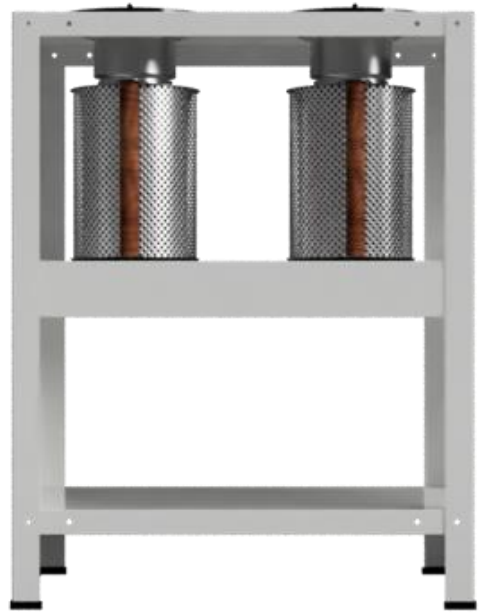
- Well established and documented. See Section XII in the white paper.
- Known costs and many benefits.
- TLUD cookstoves are the only ones that are seriously carbon negative with biochar
- Ready for instant start and payback in 5 years.

- Challenges:
  - Find humanitarian-minded wealth.
  - Funds for scale-up (with payback).

Implementation partner: Sapient of Moulindu Banerjee. Contact Paul Anderson

TLUD-FA Cookstove: FabStove (any country)

- **F**orced **A**ir **B**ase in the FABstove makes it FABulous!!!
- For-profit start-up is ready for expansion.
- Makes biochar while cooking with pellets or coconut shell pieces.



- Challenges:
  - Funding for scale-up.

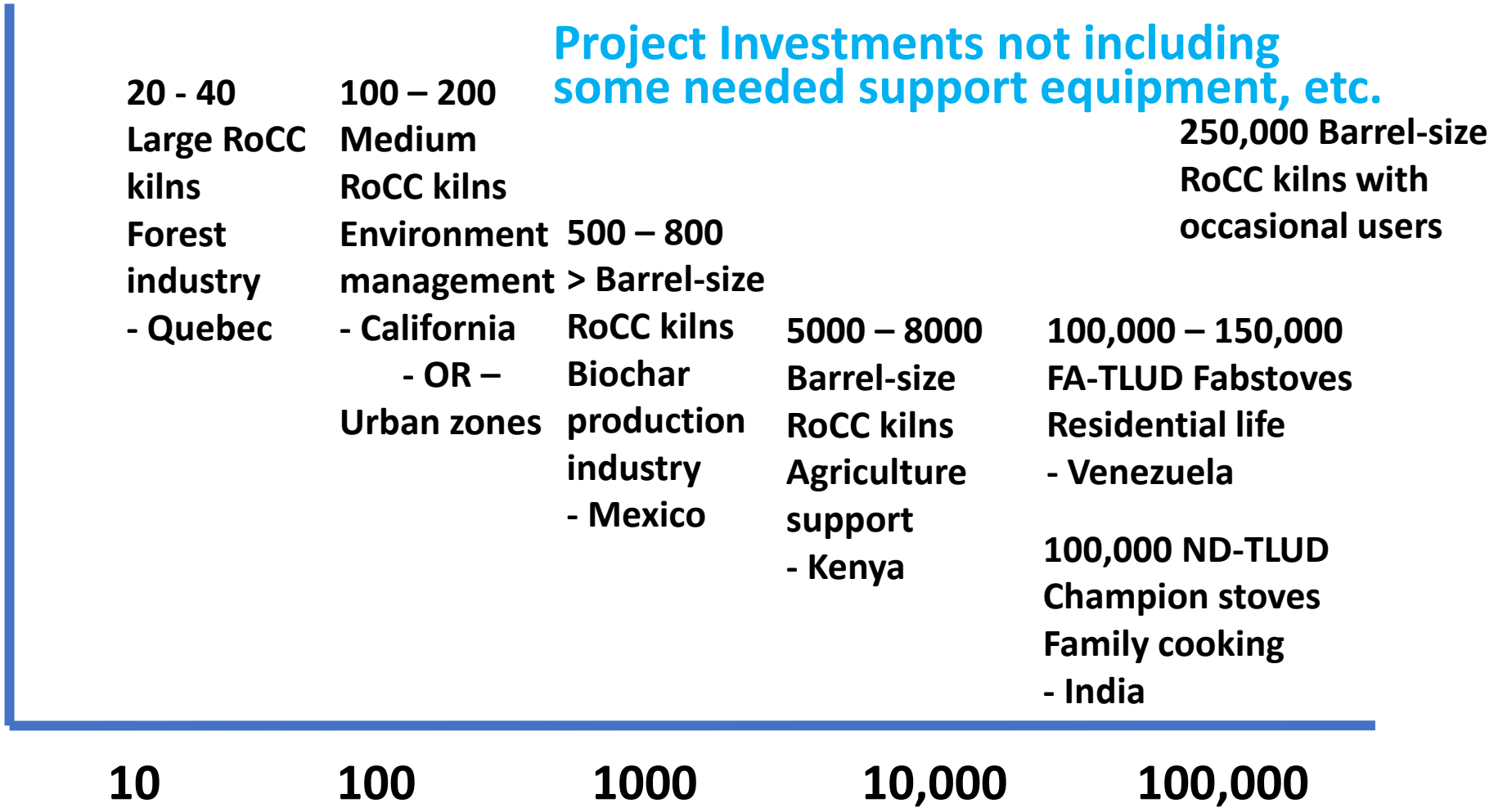
Implementation partner: Ekasi Energy. Dave Lello or contact Paul Anderson

Financing with Biochar CDR units

- **CDR = Carbon Dioxide Removal** ("removal" implies long-term storage; it could be called **CDRS** to emphasize that such storage is accomplished.)
- CDRS units = **1 tonne CO_2e** securely sequestered for at least many hundreds of years. **400 kg biochar = ~1 t CO_2**
  - Quite different from "Carbon Offset Credits" that refer to emission reductions.
- After adjustments, **1 tonne biochar = ~2.5 t CO_2.**
- **Price of 1 t CO_2 that is truly removed as CDRS** is **not** well established.
  - Technology stimulation funding pays US$100 to >$1000 per t in some cases.

Implementation Scenarios for CDR with Biochar:

Draft 2021-07 Subject to revisions; not for citation.



- The CERCS™ app ecosystem (which includes CharTrac™) from Bitmaxim Laboratories in Champaign, Illinois (USA) is the proposed digital measurement, reporting and validation (MRV) process appropriate for these project sizes.

100 t biochar per day (or 36,000 t / yr) which is equal to
250 t CO_2 removal (CDR) per day (ratio 1:2.5) or almost 100,000 t/yr that becomes

US$ 25,000 per day or ~ $ 9 million per year if valued at $100 per t CO_2e

And you still keep the char to sell but not for burning.

Implementation Scenarios for CDR with Biochar:

Draft 2021-07 Subject to revisions; not for citation.

Project Investments not including some needed support equipment, etc.

Situational Resource Level of the Project Areas (Financial & Educational)

	10	100	1000	10,000	100,000
High	20 - 40 Large RoCC kilns @ $80 K to $100 K = $1.6 M to $4 M	100 – 200 Medium RoCC kilns @ $30 K to $50 K = $3 M to $10 M	500 – 800 > Barrel-size RoCC kilns @ $2 K to $4 K = $1 M to $3.2 M	5000 – 8000 Barrel-size RoCC kilns @ $200 to $400 each = $1 M to $3.2 M	250,000 Barrel-size RoCC kilns with occasional users 100,000 – 150,000 FA-TLUD Fabstoves @ $60 each = $6 M to $9 M 100,000 ND-TLUD Champion stoves @ 40 each = $4 M
Medium					
Low					

These estimates are for after the prototype R&D has progressed for each size. Expect reductions.

The investment costs for each of the sizes are similar per annual tonne of biochar production, which is about $40 per annual tonne of CO_2 removal.

Number of operational units to produce

100 t biochar per day (or 36,000 t / yr) which is equal to

250 t CO2 removal (CDR) per day (ratio 1:2.5) or almost 100,000 t/yr that becomes

US$ 25,000 per day or ~ $ 9 million per year if valued at $100 per t CO2e

And you still keep the char to sell but not for burning.

Presentation Summary

Carbon dioxide removal and storage (CDRS) is accomplished as biochar that is created in **RoCC kilns** and TLUD stoves.

The carbon removal can be verified with the **CERCS™ App Ecosystem with CharTrac™**, leading to significant financial support.

Actual projects in **Kenya, Mexico, Quebec, USA and India** are introduced, with other projects being proposed.

The global transition from fossil fuels means TRILLIONS of dollars of new economic activity, including carbon dioxide removal. RoCC kilns are a way to participate. You are invited to be part of these activities.

Business possibilities

- **You cannot gain from the RoCC kiln technology if you do not embrace it. There are no restrictions to prevent anyone from starting to use the RoCC kiln technology. It is recommended that you stay in contact with Paul Anderson to save your time and money.**

- **When you (or others) do gain from the RoCC kiln, then part of that gain is to be provided back to Dr. Anderson who holds a patent (pending).**

- **No RoCC kilns are sold; their production and use are authorized via agreements (such as licenses) that advance the RoCC kiln impacts.**

- **Dr. Anderson is seeking and expects to identify appropriate associates and partners in numerous countries to maximize the beneficial impacts of RoCC kiln pyrolysis so that all can gain.**

- **(Continued)**

Business possibilities (Continued)

- The business possibilities are available for fabrication of units, management of units (including in projects), any use of RoCC kilns, and the resultant carbon-related benefits that include carbon markets.
- Dr. Anderson seeks impact more than financial gain.

- Contact Information:

Paul S. Anderson, PhD

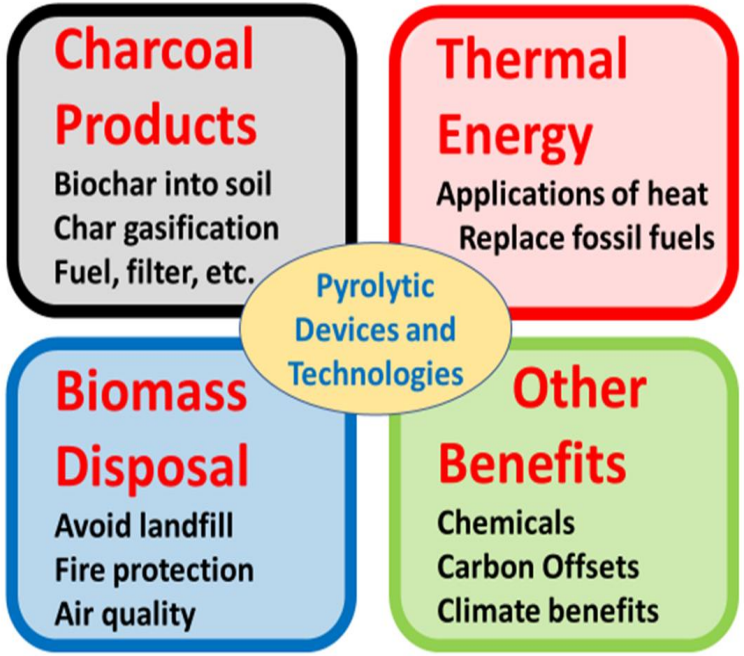
Email: psanders@ilstu.edu

WhatsApp & Mobile Phone: +1 309 531 4434 (Central Time USA)

Website for RoCC kilns and biochar white paper:

www.woodgas.energy/resources

Examples of RoCC kiln Business Prospects



- **Manufacturing** of RoCC kilns
  - Incl. future units for thermal energy
- **Research** paid for by outside funding
  - Put Dr. Anderson on your team
- Operate business with RoCC kiln **char production**
  - Produce biochar more efficiently with RoCC kilns
- Collection of RoCC biochar to produce **commercial products**
  - The focus is on final sequestration of the biochar, never to be burned.
- Transactions with carbon units for **carbon markets**
  - Dr. Anderson will use carbon markets to increase the cash flow for growth
- **Other activities** linked to RoCC kiln capabilities

The climate crisis and biochar

- **Biochar and stable carbon removal (sequestration) are in a TRILLION-dollar sector of the world economy in coming years.**

- **Carbon tracking that is necessary for receiving carbon funding for CDRS (on the voluntary carbon markets) is accomplished with CERCS - CharTrac™ app ecosystem for carbon accounting.**
  Dr. Anderson has arranged this for the RoCC kiln usage that places biochar into soil. (If interested, contact him or developer James Schoner for further information.)

Business Topics:

- The RoCC kiln technologies of devices and methods have patent (pending) protection internationally.
- Use of the RoCC kiln technologies is by license / authorization / agreement with the owner (Paul Anderson) whose compensation comes after reasonable success is attained.
- You are encouraged to participate and to use for your needs and businesses what is presented here. Dr. Anderson will help you be successful.

- The CERCS – CharTrac system is also available for use in these and other projects.

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 small 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.

Costs of RoCC Kilns (in affluent societies)

- **Barrel size (such as 55-gal drum and cylinders up to 3-ft diameter & < 4-ft long):**
  - **Do-It-Yourself (DIY)** for your own use can be **essentially free** if you use scrap, found, or hardware store items.
  - **Purchase ready made (or hire the work) for a few hundred dollars** from a supplier (who is in business for profit and needs a written agreement with the inventor).
  - [NOTE: The H-Frame design needs about US$100 for new materials in America. But labor for preparation (cut, drill, and weld) will cost hundreds more.]
- **Utility size (from 3 to 4-ft diameters and up to 10 ft long):**
  - Many variables, but likely to **cost from 2 to 8 thousand dollars,** but without mechanical operation. The inventor can assist you to locate a supplier (and save).
  - Special arrangements for those making units with features not previously included, such as for heat capture and use.
- **Bulk service size and larger:**
  - Contact Dr. Anderson for special assistance. Consider doing joint research and/or business efforts. Probably used for a heating or biomass reduction project.

Questions?

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  +1 309-531-4434

Websites:

www.drtlud.com

www.woodgas.energy

See the white paper: "Climate Intervention with Biochar"