The CERCS CharTrac Digital MRV Framework

A presentation to the Green Carbon Webinar Series

on 4 January 2024 by

Paul S. Anderson, PhD

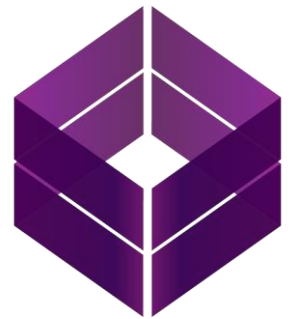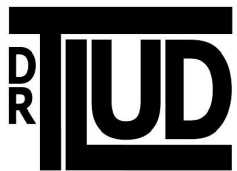Woodgas International

https://woodgas.com

CERCS Business Manager

James S. Schoner

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CERCS System Developer

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(Use the password for this Green Carbon Webinar.)

This slide deck is available at www.woodgas.com/resources

We address at least three (3) audiences …

- **Producers** of biochar (actual hands-on efforts),
  - Individuals and small efforts
  - Organized projects
- **Developers** of biochar projects
  - Strictly for biochar production
  - Full-service Carbon Dioxide Removal (CDR) projects
- **Investors** supporting biochar efforts
  - Participating in biochar project management
  - Money mainly seeking return on investment (ROI)

… and three (3) levels of computer expertise.

- **Reasonable skills**   **Advanced skills**   **Expert computer scientists**
  - **Most of us**   **A few of us**   **(You hire them.)**

Our Purpose: To Accomplish MRV for CDR

- **Measurement, Reporting, and Verification (MRV)**
    - Essential links between carbon-related actions and the sale of carbon credits.
- **Standard / typical MRV**
    - **Baseline studies, assumptions, averages, occasional site visits** to spot-check compliance.
    - **Expensive** to qualify for certification.   Some challenges to the validity of credits.
    - MRV improves with more and better data.   Data has financial value!   If useable.
- **Digital MRV (DMRV)**
    - **Real-time data capture integrated into production operations**.
    - **Encrypted and digitally signed data stored to immutable database with hash digests stored to public blockchain records**.
- **Our focus: Highest quality Digital MRV for biochar as carbon dioxide removal (CDR) and storage (CDRS).**

We are CERCS (Pronounced "serx")

- **CERCS (TM) is an ecosystem of web applications**
  - not an acronym; comes from "**C**arbon **E**mission **R**eduction / **C**arbon **S**equestration"

- **CERCS CharTrac (TM) is our core app** (now deployed)
  - **for data entry/capture with immutable tracking of char / biochar from creation to disposal as durable CDR,**
  - **for creating marketable "credits" (NFTs** = Non-Fungible Tokens**).**

- **Other CERCS apps** (in development) provide important functions:
  - CERCS LabBook (lab testing), CERCS Lambda (integration with other systems via API, IoT), CERCS GIS (location), CERCS Registry (of NFTs), CERCS Marketplace (trade/sales).

- Our **pilot project** is with Biochar Pamoja in Bungoma, Kenya, as presented on the 24 Feb 2022 Green Carbon Webinar:
  - Slide deck: https://woodgas.com/wp-content/uploads/2022/02/RoCC-Kilns-and-Biochar-in-Kenya-2022-02-24.pdf
  - Video: https://www.youtube.com/watch?v=NhlFp7RYeUU

We are CERCS

- CERCS is a 50-50 joint venture by two long-time friends.

- **Paul S. Anderson, PhD**
  - Paul handles the **business side** (funding, projects, etc.).   Pyrolysis innovator (TLUD cookstoves and RoCC kilns), biochar advocate (white paper at www.woodgas.com/resources). He is known and is similar to many of you.

- **James S. Schoner**
  - James handles the **product side**.   He is a **Senior Software Engineer and Full-Stack Web/App Developer.** Equally comfortable with the front-end (user-facing) and back-end (server processing) aspects of full-stack development. Has implemented and deployed large, complex systems, including **neural network (AI) integration**, robotics, and more.
  - Graduate of Purdue University (Computer Science and Pure Mathematics). Worked at Bell Laboratories (NJ), Caterpillar (Robotics), CPM (AI in banking), Unimin (Analytical Laboratory), MDT.
  - **Continuing education: 130+ online courses in the past decade.**

CERCS CharTrac can be used for biochar from any pyrolysis technology of any size.

Without oxygen

Earth mound

Retort

Laboratory

Adam retort

Auger kilns

Rotary kilns

Limited oxygen

Gasifiers (various types)

Glowing pyrolysis (TLUD)

Flame cap (Cavity kilns)

Open top: Pit; trench; trough; pyramid; cone; Kon Tiki; Ring of Fire

Covered top: 4C kiln and RoCC kiln

Much oxygen

Open-air piles

"Conservation burn"

"Top-down burn"

Air curtain machines

Industrial furnaces

Incinerators

Forest fires (collected char)

Technical Note:
Not referring to the oxygen that is in every carbohydrate molecule of biomass. [example $C_{12}H_{22}O_{11}$]

Requirements to use CERCS CharTrac (for CDR; ER is later)

- 1. From an appropriate biomass source and with a documented and replicable procedure, **you produce "biochar"** that must be matched with periodic laboratory testing of samples to give the basis for any claims.

- 2. The biochar must be **appropriately weighed and recorded** along with any other useful measurements (time, place, etc.) that are needed if seeking to qualify for CDR purposes. **This is YOUR data.**   Software does not improve your data.   CharTrac records what you provide.

- 3. For each recorded quantity, **ALL handling and treatment actions are recorded for tracking in later verifications.** These actions can include **transportation, aggregation, additions of non-char, and dispersal** that must eventually be defendable for claiming CDR credit.

- 4. **Consistency is key within a project.** But CERCS CharTrac is configurable and **customizable for differences between projects.**
  - The examples from the Kenya RoCC kiln project are different from your project specifications.
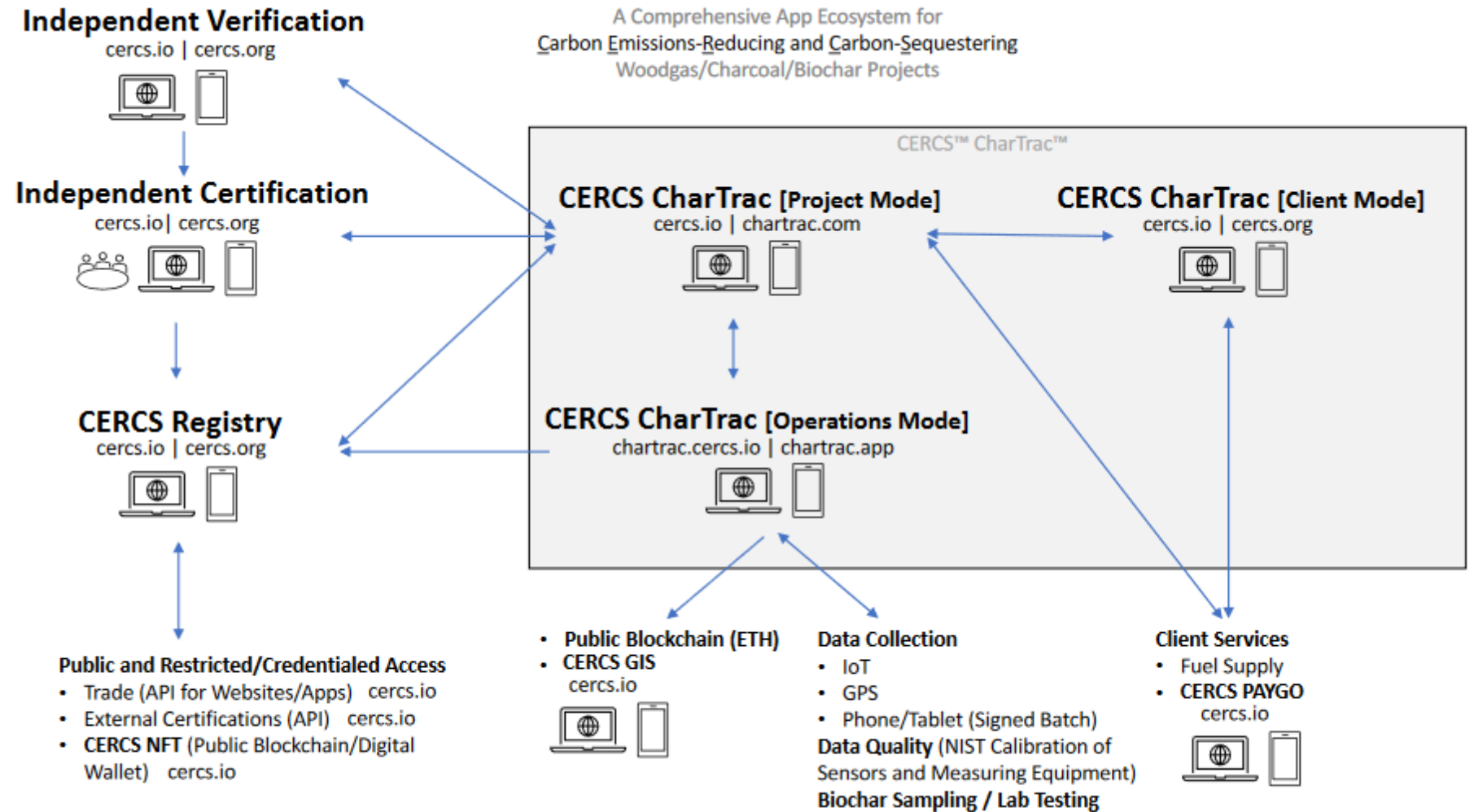
You and Your Biochar MRV

- 1. **Standards** are set by the "authorities." We are to comply or be better.

- 2. You **MUST have MRV support** if your CDR is to be "verifiable."

- 3. There are competing MRV services.   Your can **use more than one MRV system and compare the quality** of the data handling.   What you cannot do is sell the CDR credits to more than one purchaser.

- 4. CERCS CharTrac will participate in comparative studies.

- 5. **The CDR credit purchasers will be the ultimate judges of what is valid.**

Transition to more technical content

- What follows is an **introductory overview** of the way fundamental computing and web technologies are utilized in CERCS CharTrac for Digital MRV to obtain potentially higher-value CDR credits from biochar activities.

CERCS CharTrac:
The Heart of a Connected App(lication) Ecosystem

- **The CharTrac app is the workhorse.**

- API provides data connections to other apps (CDR market sites, GIS, PayGo, digital wallet, etc.).

Independent Verification
cercs.io | cercs.org

Independent Certification
cercs.io | cercs.org

CERCS Registry
cercs.io | cercs.org

Public and Restricted/Credentialed Access
- Trade (API for Websites/Apps)   cercs.io
- External Certifications (API)   cercs.io
- **CERCS NFT** (Public Blockchain/Digital Wallet)   cercs.io

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

CERCS™ CharTrac™

CERCS CharTrac [Project Mode]
cercs.io | chartrac.com

CERCS CharTrac [Client Mode]
cercs.io | cercs.org

CERCS CharTrac [Operations Mode]
chartrac.cercs.io | chartrac.app

- **Public Blockchain (ETH)**
- **CERCS GIS**
  cercs.io

Data Collection
- IoT
- GPS
- Phone/Tablet (Signed Batch)

Data Quality (NIST Calibration of Sensors and Measuring Equipment)

Biochar Sampling / Lab Testing

Client Services
- Fuel Supply
- **CERCS PAYGO**
  cercs.io

CERCS Operational Facts

- **To start, the biochar project owner must register the project with basic information and authorize any users.**

- User accounts in the CERCS system are assigned a role from a hierarchy that determines user-level authorizations. **Only the owner's authorized personnel can sign and commit data or reject anomalous data from their data collectors.**

- **CERCS administrators will not intervene on client's behalf to enter, sign, filter, or alter any data attached to client operations.**

CERCS CharTrac App In Use During A Charcoal Collection Route in Venezuela

Lucymar, Venezuelan FabStove User with iron storage pot containing saved charcoal

Charcoal Collector, Daniel, weighing a bag containing Lucymar's charcoal

CERCS CharTrac for Data Collection at a RoCC Kiln Charcoal Production Site for the Biochar Pamoja Alpha Project in Kenya

Photograph taken by the CERCS CharTrac App of the Kiln ID Plate (BP004) held by Haron, the Kiln Operator pictured with his CERCS User ID Card. The temporary Kiln ID was later permanently engraved or otherwise attached as a metal plate to the kiln structure.

Weighing the **dry charcoal** in a pre-weighed barrel with lid.

FRED NAMAZAKHE 2	MOSES SHIRAVU 3
HARON MUKWAMBO 4	ANDREW MUKWAMBO 5
MICHAEL WAFULA 7	JOSEPH MASIKA 6

CERCS WordPress Dashboard Plugin

(CERCS Dashboard Widgets For WordPress Content Areas)

No time to read this, so I will show a short demonstration video.

- Dashboard plots and maps update in real time when new data transmissions are received by CERCS servers.

- These real-time updates appear in the app and wherever the CERCS dashboard widget (WordPress plugin) is installed.   For example, the CERCS Dashboard plugin is installed at the Woodgas International website (woodgas.com), with the dashboard widget appearing on each country-specific page.   Additionally, the same widgets may appear on the operation owner's website, assuming the owner uses WordPress.

- Note that public-facing dashboard components are configured by default to hide sensitive location details, such as not allowing a website visitor to use the map's "+" (zoom) button to refocus the detail so that individual houses or driveways are visible. Other personally-identifying data items are anonymized prior to their use in a public-facing dashboard component.   This is not the case for dashboard components that are displayed for logged-in CERCS operation owners and managers.

Real-Time Dashboard Map Of Arriving Data Transmissions
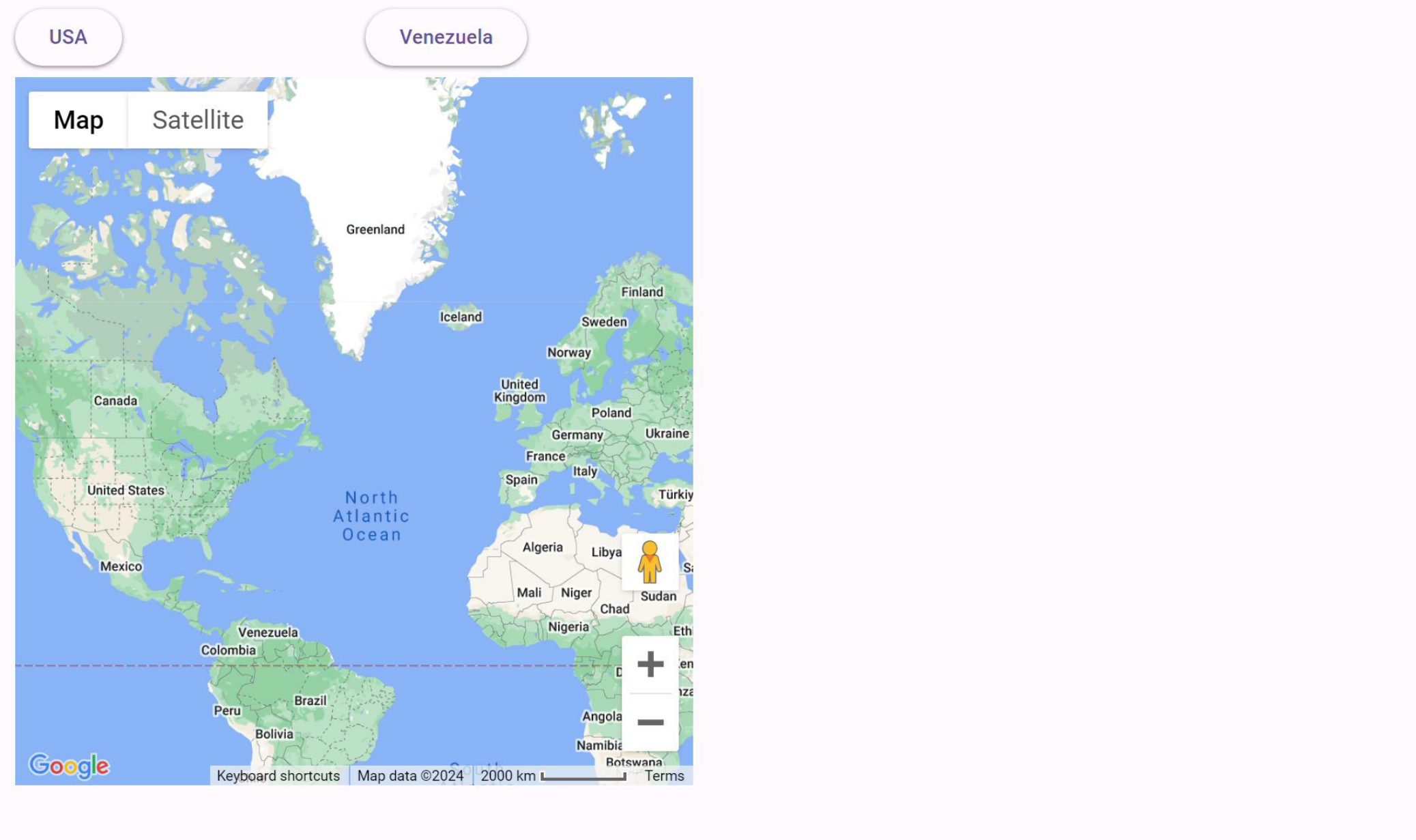
One of Many In-App Data Visualization Plots that also Appear as Configurable Dashboard Components for the Project Operation
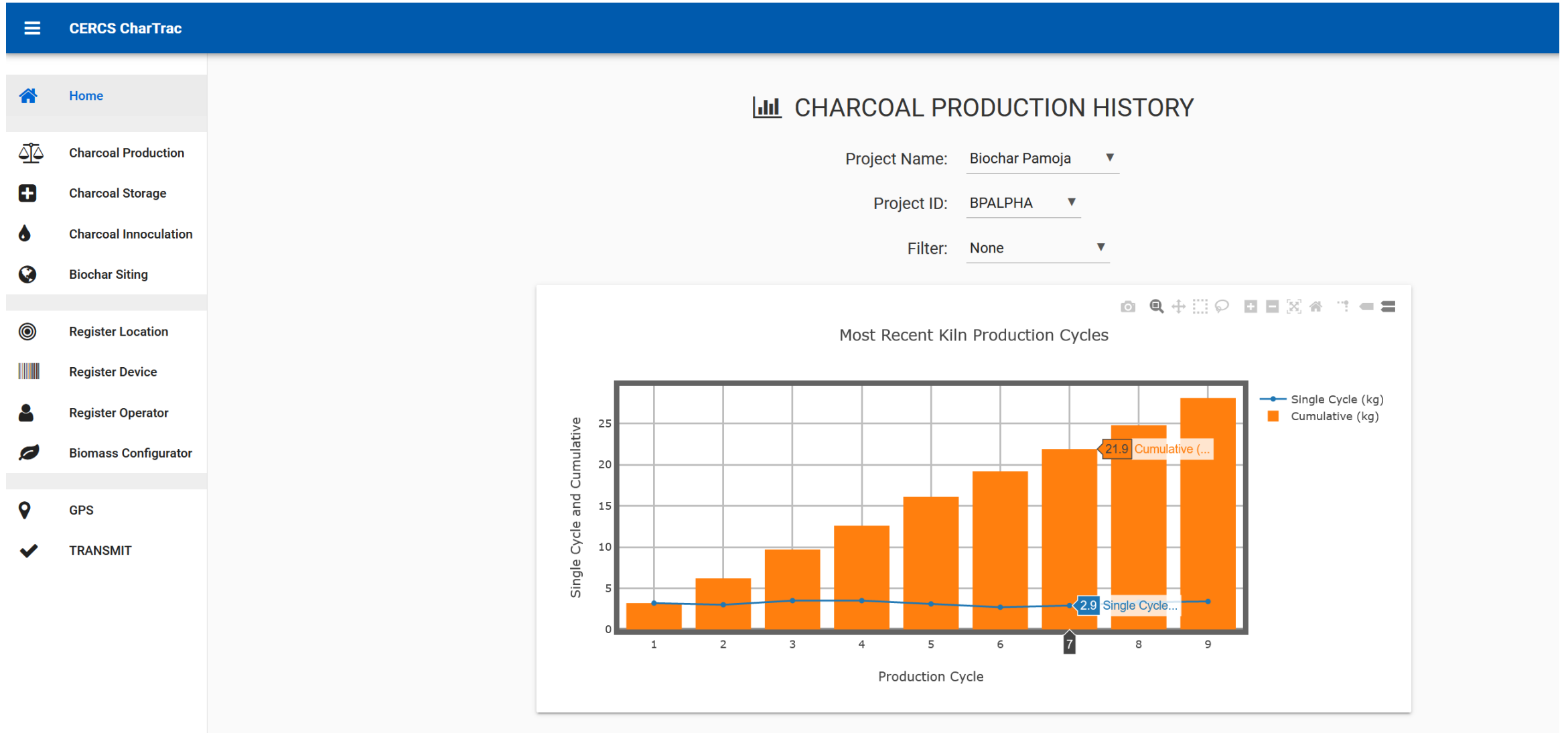
CERCS CharTrac: Security in Communications

- **Encryption and digital signing are used together.**
- Digital signing and encryption **protect data** from compromise and **authenticate the sender** at the same time.
- They are also both used in tandem to **fulfill compliance standards** for companies.
  - Standards, like the **Federal Information Processing Standards (FIPS)** or the **General Data Protection Regulation (GDPR)**, require companies to protect data as securely as possible along with authenticating data received from others.
- Encryption and digital signing ensures these standards are met, and that users can be secure in the knowledge that data that is sent to and from them will not be compromised.

CERCS CharTrac: Hash values with blockchain.

- A **hash value** is a unique, fixed-length sequence of alphanumeric characters that is associated with a particular data set. Example:

  ```
  0x285aea0e4e4605f28c89ea20253456e98c5
  fb999d3988084b8ad1ed82f36fb2e
  ```

  - If any part of the data set is altered in any way, the resulting hash will be different.
  - It's not possible to tamper with the data set without changing its associated hash value.
  - **Once entered into the system, the data are immutable. Any data that are incorrect can only be deleted or tagged with separate, explanatory comments.**

Computational Efficiency

- **CERCS stores only hash values (data fingerprints) to the blockchain.**

- Encrypted data is stored to **Immudb**

- Associated file assets are stored to the **Interplanetary File System (IPFS).**

- CERCS also **mints NFTs (carbon credits) on the same blockchain**, ready for the CERCS Registry and CERCS Marketplace.

CERCS CharTrac: Developed with Algorand

- After initial development with Ethereum, **CERCS CharTrac now uses the Algorand blockchain.**

- Algorand was chosen for its groundbreaking features and energy efficiency **("the green blockchain").**

We learned about Algorand through its sponsorship of the 2022 Premios Verdes (Latin American Green) Awards Ceremony in Miami, Florida. Paul Anderson and his Venezuelan associate, Daniel Velasquez, won two (2) awards for their collaborative biochar work in Venezuela.

BIOCHAR Y ENERGÍA PARA EL SECUESTRO DE CO2 EN SUELOS

Quality Assurance (QA) Management

QA Management includes:

- Sampling

- Testing

- Scale calibration checks

- Round Robin Studies

- Error checking

- Consistency of operations by an operator and between operators.

- **Determination of DRY weight of produced biochar.**
  - Moisture content (MC) of biochar changes over time, but the actual fixed carbon remains the same when based on DRY weight.
  - Appropriate DMRV tracks the fixed (stable) carbon and its CO2e, even when it is unseen and no longer measureable, as when in piles of compost and manure.

Example of Spotting a QA Issue

Periodic photographs taken via the CERCS CharTrac Mobile App are seen by managers who review/ approve data sets from the app.

These images can be important in uncovering operating issues that affect accuracy of measurements due to deviations from established operating procedures.

Weight Measurements and CDR Credits

- CDR credits as CO2e come from
  - **DRY weight of Biochar times % Fixed Carbon times 3.66 (then minus deductions)**
- **Moisture content (MC)** is zero if weighed without liquid quenching, providing full confidence in knowing the DRY weight. Once the dry weight is recorded, moisture and solids can be added without impact on CO2e.
- This is what is done in the pilot project in Kenya with RoCC kilns.
- If biochar receives moisture before weighing, ALL subsequent determinations of DRY weight are estimates based on testing of samples and deriving statistical averages, and are reported as such in CERCS CharTrac.
- **Use of CERCS LabBook** features help determine the MC variations.

CERCS™ LabBook

- The CERCS™ LabBook collection **provides a standardized framework for reporting signed and certified lab results** through secure (encrypted and signed) data transfers directly from the analysts and certifiers at each analytical (testing) laboratory.

- The CERCS™ LabBook component provides a growing selection of laboratory notebooks for use by charcoal/biochar testing labs.

- **Developed with open standards** in the next-generation JupyterLab environment, these lab notebooks integrate with the CERCS™ Registry for the purpose of rating carbon units according to quantitative determinations of fixed carbon in charcoal/biochar material sampled from production operations that use our CharTrac component.

Integration Features

- The CERCS™ Lambda component provides **configurable connectivity options** that facilitate a range of features and secure functionalities, including **API endpoints, IoT interfaces/middleware, file-sourced data ingestion, data sharing, and data pipelining.**

- **Note: To fully appreciate the software complexity of the CERCS app ecosystem, your software experts will need to be in touch with James Schoner, the CERCS software developer. The CERCS ecosystem implements a wide range of capabilities, with IoT, an API Library, and much more.**

CERCS Business Status – January 2024

- **Launching** CERCS CharTrac for DMRV now.　• **We have no debts.**

- Organized for long-term operations. • **Totally sustainable** while small.

- **Ready for rapid scale-up** as clients and funding become available.

- **API Library for communications** with other programs.

- Developed **to include AI-powered analyses and user assistance**.
  - Verbal commands for data entry and reports.
  - Checking for data quality issues.

- **Anticipating union or association** with businesses focused on standards, data handling, project management, R&D, carbon credit transactions, third-party verification, investments and climate action.

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(Use the password for this Green Carbon Webinar.)

Three Ways to Participate with CERCS CharTrac

- 1. **Producers USE** CERCS CharTrac for your biochar-to-CDR efforts.
  - Free sign-up for info updates at https://cercs.io home page.
  - Free trial experience: (Coming 2nd Quarter 2024)
  - Initial small users (to be screened and with payment in range of $1k to $10k)

- 2. **Developers COLABORATE** for joint R&D efforts: Build CharTrac into your project MRV budgets, such as for Milkywire (CTF) pre-purchase agreements or your research efforts. (starting at $10K)

- 3. **Investors JOIN** for business: Become a partner in the CERCS business future. Seeking skills and experience regarding management, standards, software development, etc. as well as funds for faster scale-up and additional features. (starting at $100k and depending on arrangements.)

Make first contact and receive updates via
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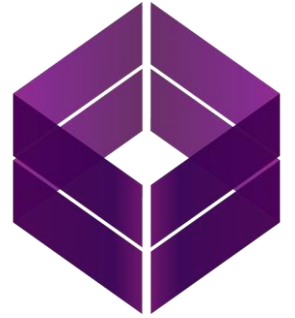
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