PowerPellet TLUD-ND Cookstove and Service Project in Kenya

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This presentation is available at https://woodgas.com/resources

Abstract: (as published but reformatted)

PowerPellet TLUD-ND Cookstove and Service Project in Kenya

Presenter: Paul S. Anderson with Co-author: Gilbert Mwangi

We present the complete details of an ongoing cookstove project in Bungoma, Kenya, including

1) the distinctive PowerPellet TLUD-ND stove characteristics;

2) fuel issues; **3) TEG power generation;**

4) emissions; **5) humanitarian mission;**

6) financial issues;

7) carbon credits for both emission reduction (ER) and carbon dioxide removal (CDR);

8) scale-up; **9) user feedback; and**

10) lessons learned for cookstove success.

Understanding a complete project from A to Z reveals the interconnected workings needed for appropriate sustainable success.

1) The distinctive PowerPellet TLUD-ND stove characteristics

- Natural Draft TLUD stove (no fan)
- Makes electricity with a ThermoElectric Generator (TEG)
- Pot sits on stove body
- Interior perforated grate
- Supports pellet fuel.
- Detachable bottom with three legs

TECHNICAL SPECIFICATIONS and SUPPLIER

Weight	**10 kg**
Height	51 cm
Width	45 cm
Length	22 cm
Consumption per hour	1 kg pellet/h

Table 6: Safety results

Safety Test Component	Rating	Sub score	Score
1.Sharp edges	Good	3	4.5
2.Cook stove tipping	Best	4	12
3.Containment of fuel	Best	4	10
4.Obstructions near cooks surface	Best	4	8
5.Surface temperature	Poor	2	4
6.Heat transmission to surroundings	Best	4	10
7.Handle temperature	Poor	1	2
8.Chimney shielding	Best	4	10
9.Flames surrounding cook pot	Best	4	12
10.Flames exiting fuel chamber	Best	4	16
Total safety factor score			88.5%
Tier Rating			3

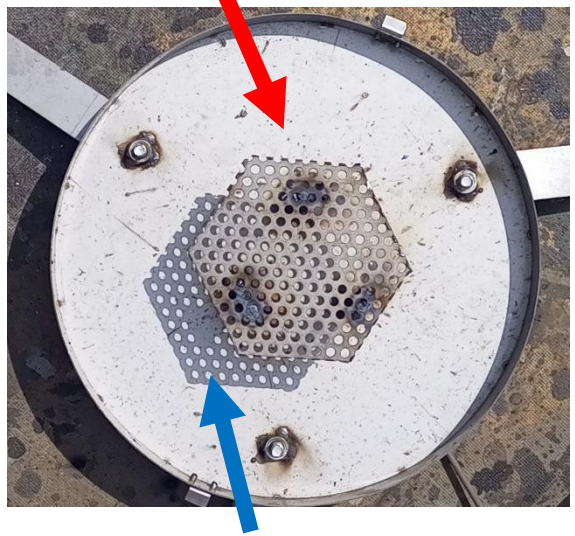
- Designed and owned by PowerSpot, a Spanish company; now registered in Kenya as ACE Pellets, a pellet fuel producer.
- ~2000 units made in China; imported; ~800 are still available in Kenya.
- Cost >US$100 each (Production + Importation)
- Tested by a certified laboratory
- Modified by Biochar Pamoja for collection of biochar.

Modification for biochar collection (by Biochar Pamoja)

- Cut a hexagon into the interior grate.
- Weld hexagon onto the removable bottom by adding three support legs.
- When pyrolysis is completed, release the base, raise the stove body, and the biochar falls into the base for collection.

The purpose is to be able to save the biochar when pyrolysis is completed.

Hexagon on 3 supports



Shadow of hexagon

2) Fuel issues

- The PowerPellet stove is designed for use with standard biomass pellet fuel, a modern dense uniform fuel.
- The ACE Pellet company makes tonnes of pellets for industrial customers and provides pellets for the cookstove users at favorable pricing.
- The ACE pellets are made from abundant sugarcane bagasse from sugar mills around Kakamega, Kenya, 40 minutes from the stove project location in Bungoma, Kenya.

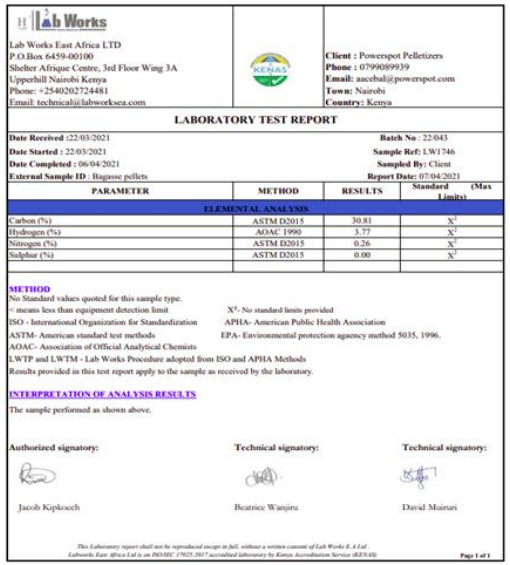
1.2 Fuel

The fuel used was pellets processed using bagasse and was supplied by the client from Western Kenya; Its properties are listed on table 3 below.

Table 3: Fuel Properties

Description/biomass species	Bagasse Pellets
Source	Supplied by client
Energy Content	13673.3kj/Kg
Moisture Content	7.5%

Test results of bagasse pellets and resultant biochar



Lab Works

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Client : Powerspot Pelletizers
Phone : 0799089939
Email: aacebal@powerspot.com
Town: Nairobi
Country: Kenya

LABORATORY TEST REPORT

Date Received :22/03/2021 — Batch No : 22/043
Date Started : 22/03/2021 — Sample Ref: LW1746
Date Completed : 06/04/2021 — Sampled By: Client
External Sample ID : Bagasse pellets — Report Date: 07/04/2021

PARAMETER	METHOD	RESULTS	Standard (Max Limits)
ELEMENTAL ANALYSIS			
Carbon (%)	ASTM D2015	30.81	X²
Hydrogen (%)	AOAC 1990	3.77	X²
Nitrogen (%)	ASTM D2015	0.26	X²
Sulphur (%)	ASTM D2015	0.00	X²

METHOD
No Standard values quoted for this sample type.
< means less than equipment detection limit
X²- No standard limits provided
ISO - International Organization for Standardization
APHA- American Public Health Association
ASTM- American standard test methods
EPA- Environmental protection agency method 5035, 1996.
AOAC- Association of Official Analytical Chemists
LWTP and LWTM - Lab Works Procedure adopted from ISO and APHA Methods
Results provided in this test report apply to the sample as received by the laboratory.

INTERPRETATION OF ANALYSIS RESULTS
The sample performed as shown above.

Authorized signatory: Jacob Kipkoech — Technical signatory: Beatrice Wanjiru — Technical signatory: David Muiruri

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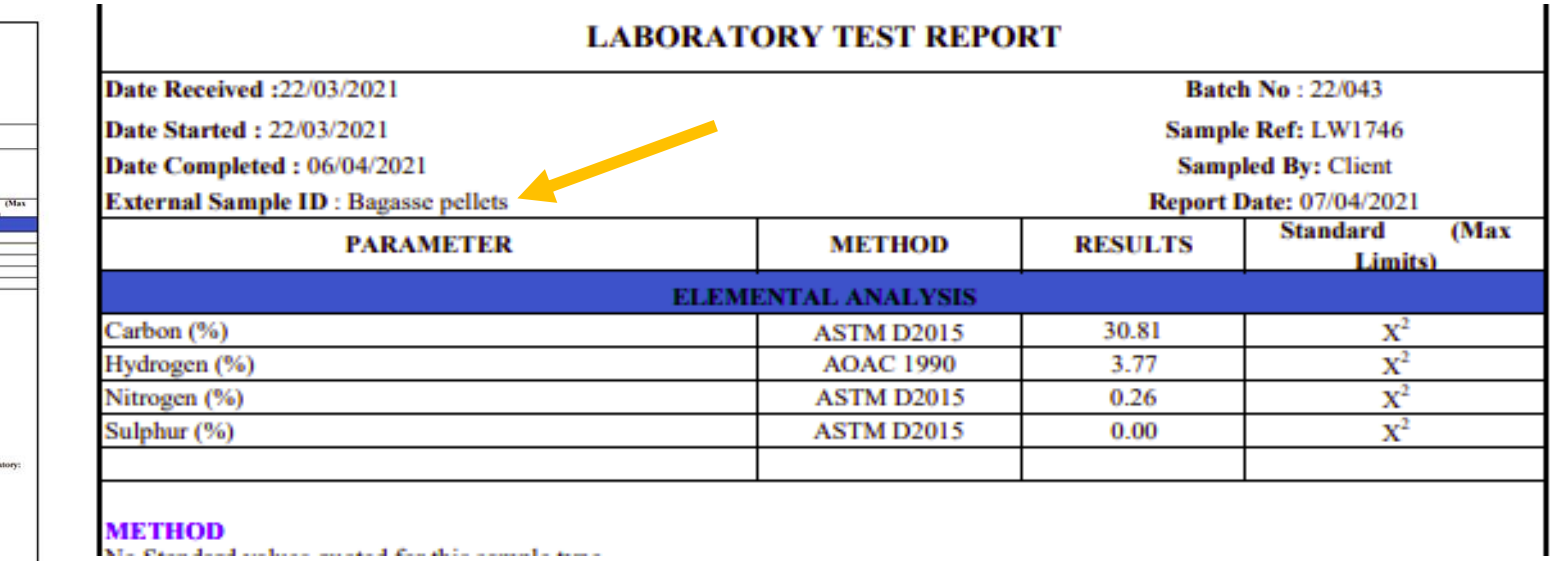
Page 1 of 1



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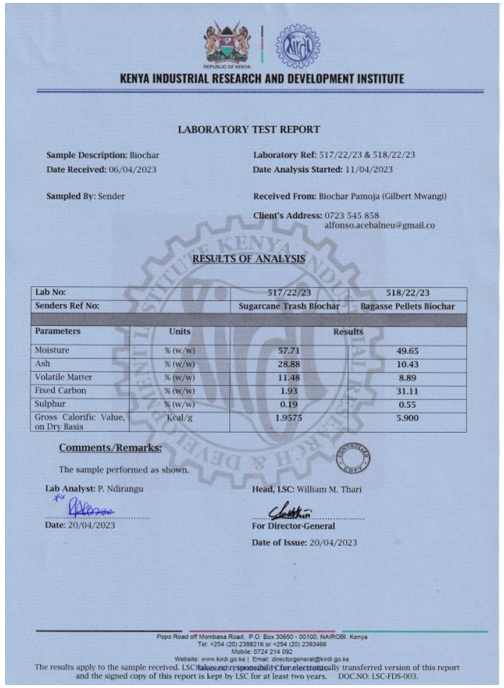
METHOD

Only 34.8% is described. The 65% remainder is ash (est. <15%) & Oxygen.



KENYA INDUSTRIAL RESEARCH AND DEVELOPMENT INSTITUTE

LABORATORY TEST REPORT

Sample Description: Biochar — Laboratory Ref: 517/22/23 & 518/22/23
Date Received: 06/04/2023 — Date Analysis Started: 11/04/2023
Sampled By: Sender — Received From: Biochar Pamoja (Gilbert Mwangi)
Client's Address: 0723 545 858 alfonso.acebalneu@gmail.co

RESULTS OF ANALYSIS

Lab No:		517/22/23	518/22/23
Senders Ref No:		Sugarcane Trash Biochar	Bagasse Pellets Biochar
Parameters	Units	Results	
Moisture	% (w/w)	57.71	49.65
Ash	% (w/w)	28.88	10.43
Volatile Matter	% (w/w)	11.48	8.89
Fixed Carbon	% (w/w)	1.93	31.11
Sulphur	% (w/w)	0.19	0.55
Gross Calorific Value, on Dry Basis	Kcal/g	1.9575	5.900

Comments/Remarks:
The sample performed as shown.

Lab Analyst: P. Ndirangu — Head, LSC: William M. Thari
Date: 20/04/2023 — For Director-General
Date of Issue: 20/04/2023

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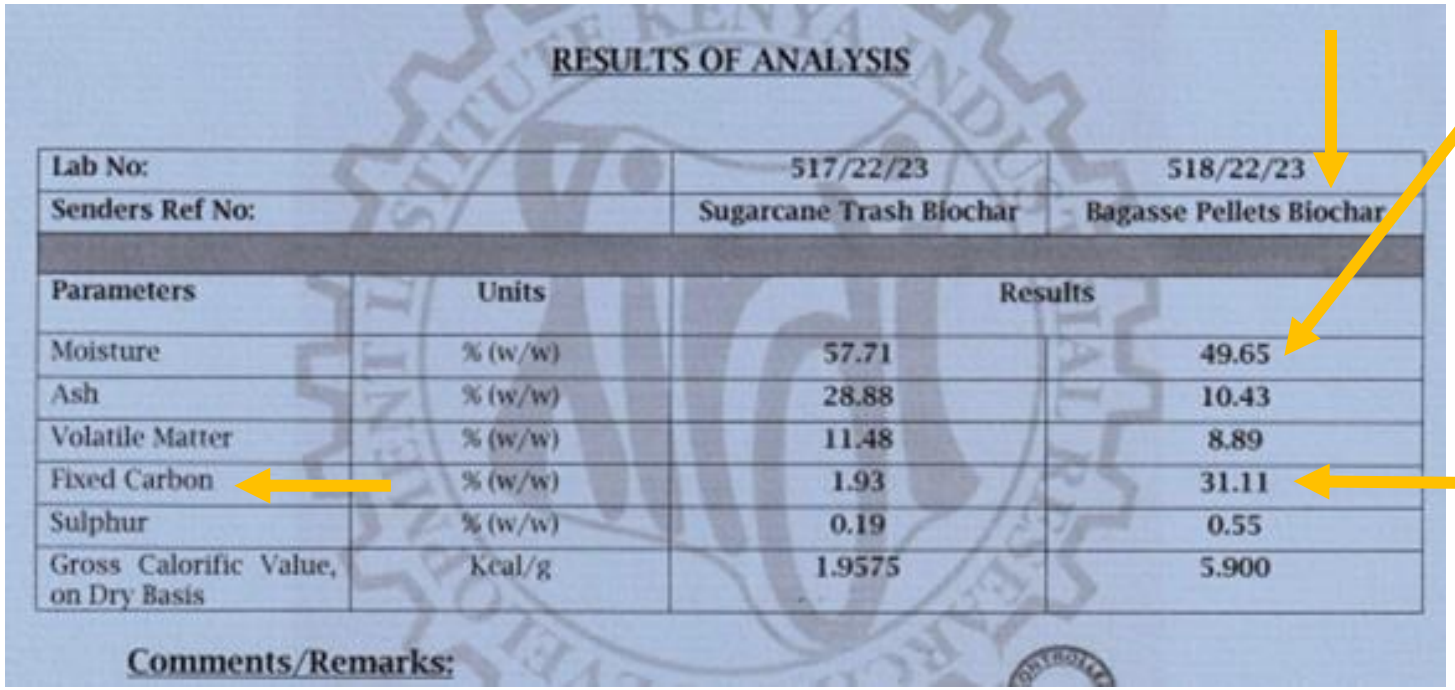
Tel: +254 (20) 2388216 or +254 (20) 2393466
Mobile: 0724 214 092
Website: www.kirdi.go.ke | Email: directorgeneral@kirdi.go.ke
The results apply to the sample received. LSC takes no responsibility for electronically transferred version of this report and the signed copy of this report is kept by LSC for at least two years. DOC.NO: LSC-FDS-003.



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Comments/Remarks:

~50% water means the DRY weight percentages are ~double.

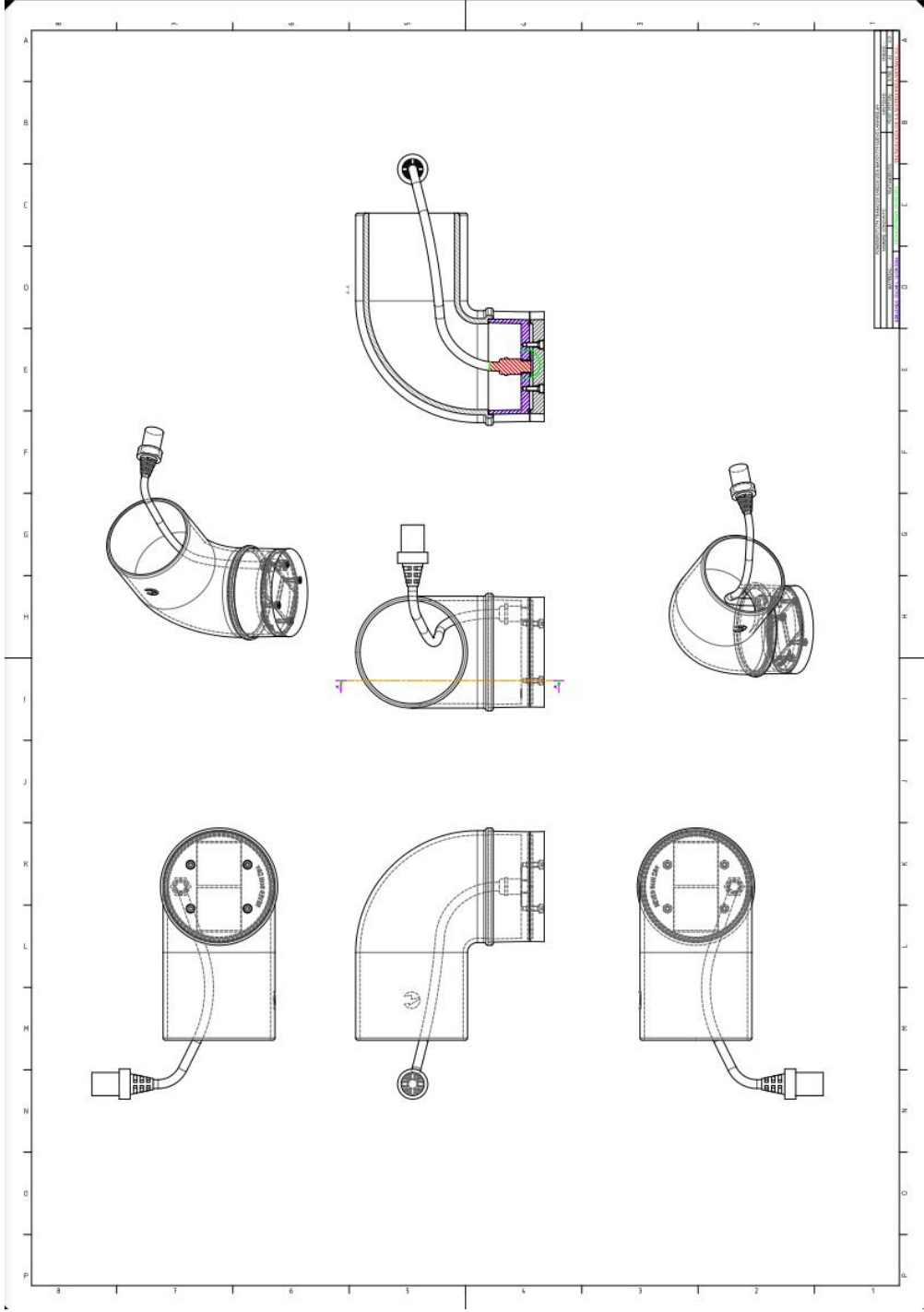
Fixed carbon = 62%

3) TEG power generation

Max voltage	14 V
Power (sustained)	8 W
Lifespan	50,000 h
Operating temperature (the safe range for the hot side of the TEG)	150˚C - 650˚C

- The elbow is filled with water that cools the TEG even when the water is boiling.

TEG Power generation



TEG Power generation (accessories included)

Sustained power of 8 Watts is sufficient for an LED light and for mobile phone charging.

4) Emissions and Efficiencies of PowerPellet TLUD

- As with all well made and properly operated TLUD cookstoves, the emissions are exceptionally low.
- Testing was done at KIRDI.

2 .0 Test Methodology

The test stove was tested as per ISO 19867 Test Sequence protocol while using the Laboratory Emissions Monitor (LEMS) to capture the emissions of the stove. The stove was operated on High and Medium considered .The calorific value of the charcoal was determined by using a bomb calorimeter at KIRDI Laboratories and the Moisture content was determined by oven method.

3.0 Cook Stove Performance Results

The results of the cook stove performance which covers thermal efficiency, emissions for CO and PM2.5 is summarized on table 5 below. The stove's rating was evaluated as per ISO 19867 Voluntary Performance Targets for emission factors. Further details are presented at Appendix 1.

Table 5. Summary performance metrics for thermal efficiency and pollutant emissions.

Metric		Test Sequence			Tier rating	Remarks
		High	Medium	Combined		
Thermal Efficiency	Mean	43%	47%	45%	4	The stove performance on efficiency is fairly good
	SD	0.01	0.02	0.015		
PM2.5 per useful energy (mg/MJ_d)	Mean	25.29	29.96	27.63	4	The Performance on PM Emissions is good
	SD	12.68	6.6	9.64		
CO per useful energy (g/MJ_d)	Mean	5.69	8.725	7.21	3	Performance on CO is fairly good but can still be improved
	SD	0.73	1.51	2.15		

5) Humanitarian mission

- **Objective: To bring exceptionally clean cooking to households in Kenya.**
- The **Rotary Clubs** of Bungoma Magharibi (Kenya) and Bloomington-Normal Sunset (Illinois, USA) have started assisting 5 Women Self-help Groups (WSGs) to obtain modern TLUD clean cooking.

Women Self-help Groups (WSGs) with TLUD Stoves

- **Initially 5 stoves to each of 5 groups**

6) Financial issues (Slide 1 of 2)

- For reasons related to Rotary donations and the claiming of any carbon credits, **ownership of the stoves is by the WSG**, not by the individual members or households.
- The WSG can **acquire additional stoves @~20 US$** each as funds become available from members or other sources.
- Because the cost of each stove is subsidized by the ACE Pellet business, **all stove use must be with ACE pellets.**
  - There are no other suppliers of pellets in the area.
- The pellet price is KES 35 /kg (~0.23 US$/kg). **Pellet fuel costs per cooking task are similar to purchasing charcoal** and much less than for cooking with LPG or kerosene.
- Pellet sales are through each **WSG that earns about 10% per kg.**

6) Financial issues (Slide 2 of 2)

- **Rotarians in Bungoma assist** with social interaction with the WSG and with the donors.
- **Overall coordination of the project is by Biochar Pamoja**, a business owned and operated by Gilbert Mwangi for the production and handling of biochar from RoCC kilns and TLUD stoves.
  - Biochar Pamoja (which means "together) is assisted by Paul "Dr TLUD" Anderson
  - Biochar Pamoja has responsibility for user training, stove maintenance, pellet fuel supply chain, supply of additional stoves, physical biochar handling, and carbon credit services.
- **The primary objective of the sales of carbon removal (CDR) credits is to help finance the placement and use of additional TLUD stoves,** not to give further financial benefits to those who already benefit from this stove project.

7) Carbon credits for both emission reduction (ER) and carbon dioxide removal (CDR);

- The initial collection of biochar of pellet fuel from 25 PowerPellet stoves is in late January 2024. This is for carbon removal (CDR). ER would be extra.
  - **~10 kg pellets/wk/stove** = ~500 kg pellets/yr that will yield ~100 kg biochar/yr.
  - Each kg @60% fixed carbon = 2.2 kg CO2e removed (CDR), being ~220 kg CDR/yr.
  - With CDR credits = ~140 USD per tonne, **each stove earns ~ 30 USD/yr for CDR.**
  - Success is with numbers. 250 such stoves in use generates ~7500 USD/yr.
- Data from the biochar operations are captured by collectors who use the mobile app, **CERCS CharTrac.** This app implements a new, comprehensive **Digital MRV** framework for transparency, traceability, and quality of credits.
- This project is FOAK (first of a kind) with CDR via biochar-producing stoves. It could eventually lead to **TLUD stoves in millions of low-income homes with significant benefits for numerous Sustainable Development Goals (SDGs).**

8) Scale up

- The initial 25 PowerPellet TLUD-ND stoves were placed in homes in December 2023, with funding from Rotary Clubs.
- Members of the Women Self-help Groups might acquire an additional 25 – 50 in 2024. Plus further donations, **we expect 100 stoves in use this year.** This is still too small to be a self-sustaining project.
- A goal is to have all 800 available PowerPellet TLUD-ND stoves in use in homes by the end of 2025, forming a viable pilot study.
- For further expansion, we anticipate **the availability of Fabstoves that are now being industrially produced by Ekasi Energy of South Africa.** They are TLUD-FA (forced air or fan assisted) stoves with similar pricing that use pellet fuel, but without the TEG features.
- A full demonstration project with 1000 to 2000 stoves will provide the factual data for similar projects to begin with great confidence of success.

9) User feedback

Mariam Juma.
Chairperson, Naitela WSG, Bungoma, Kenya.
" I had to make sure to attend the Rotary Club of Bungoma Magharibi fellowship today. We had not heard of Rotary Club before the cookstoves project. I have come here today with two of my daughters to purposely thank you for the donation of cookstoves that are now improving and transforming our lives.

"... cookstoves that are now improving and transforming our lives."

Carolyne Wameme.
Chairperson, Senna WSG. Bungoma, Kenya.
"At least women now have an opportunity to improve the environment. This has made our work easier. This is because we shall not be rushing into the fields to fetch firewood wherever we need to prepare our families food. The cookstove is family friendly because everyone can prepare meals on it."

"... we shall not be rushing into the fields to fetch firewood whenever we need to prepare ... food."

9) User feedback

MacLean Kisabuli.
Chairperson, Bidii Yefwe WSG, Bungoma, Kenya.
" Today we are very happy and excited because some members shall start cooking their meals without stress. Most of us go to our kitchens to prepare ourselves and families a meal but come out smelling smoke and eyes burning. We are truly very grateful for these clean cook stoves."

"We are truly very grateful for these clean cook stoves."

Janet Mangara.
Treasurer, Joy WSG.
Village Elder, Chemche B, Bungoma, Kenya.
" Am very very happy for the donation of cookstoves. Our families and the elderly shall now enjoy clean food without the effects of smoke. We now have pellets for cooking rather than wasting lots of time fetching firewood."

"Our families ... shall now enjoy clean food without the effects of smoke."

10) Lessons learned for cookstove success.

Some are confirmations of prior-known lessons.

- **Sugarcane bagasse** is an excellent cooking fuel when pelletized.
- **End user education** on how to use TLUD clean cookstoves is key.
  - Ignition at the top needs to be shown and learned.
  - The timing when to harvest biochar is crucial and is learned by experience.
  - Explain the reasons **not to continue cooking with the produced char.**
- The **cooking duration** of different food types impacts stove usage.
- **Reloading the fuel canister during cooking** is a major challenge.
  - Therefore preference for cooking fast items with no refueling.
  - The reloading issue is less with the Fabstove and Champion designs with separate pot support and removable gasifier canisters.
- **Charging mobile phones** is greatly appreciated.
- More lessons will be coming very soon.

Conclusion

Understanding a complete project from A to Z reveals the interconnected workings needed for appropriate sustainable success.

Q & A and Contact

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