



**BERKELEY AIR
MONITORING GROUP**

protecting health and climate

Pilot Evaluation of the Diffusion and Use of Clean Cooking Technologies in Lagos, Nigeria (PEDUCCT): Results Brief

July 2018



Study Introduction

A consortium of Nigerian private sector partners, anchored by Project Gaia Partners Limited (Project Gaia) and Shell Nigeria Exploration and Production Company (SNEPCo), is exploring how to promote ethanol-methanol fuel for cooking in West Africa, with a pilot project designed to roll out as a commercial start-up in 2018-19. An initial 2,500 CleanCook stoves (see box) and 15,000 alcohol-fuel canisters will be sold in selected neighborhoods of Lagos. The consortium also includes Forte Oil, a leading fuel sales and distribution company with over 500 retail outlets, and UNIKEM Industries Ltd. In order to support the commercial scale-up of the CleanCook stove and ethanol-methanol fuel blend, an assessment, entitled **Pilot Evaluation of Diffusion and Usage of Ethanol Clean Cooking Technology (PEDUCCT)**, was launched in 2017 with funding from the African Development Bank.

The CleanCook Stove



The alcohol-fueled CleanCook stove has 2 burners, a stainless-steel body, and an expected lifespan of 8 to 10 years. It is currently manufactured in Durban, South Africa, and has a factory cost of ~24,000 Naira. The ethanol-methanol fuel is delivered to the burners through a system of fiber-filled adsorptive canisters that allow the user to adjust the heat level while eliminating the risk of burns or fuel ingestion.

Study Approach

Objective	Method Details
This early-stage observational study aimed to collect the data necessary to explore and improve the potential for successful ethanol technology scale-up, including information on cooking patterns, customer perceptions, and willingness to pay.	In-home field assessments were undertaken in an experimental sample of 30 households for up to 6 months.
	A combination of sensor-based stove-use measurements, canister refill monitoring, and household surveys were used to measure uptake, use, and acceptability of the CleanCook.
	The evaluation also included performance testing of both the CleanCook with the ethanol-methanol fuel and a local kerosene stove conducted at the National Center for Energy Research and Development (NCERD) laboratory at the University of Nigeria, Nsukka, to estimate emission factors/rates and fuel efficiency.
	Although the original study design also included a parallel study of early purchasers, this component could not be completed as the assessment period concluded prior to the CleanCook's market launch, which is still awaited.

Note that a complete description of the methods is presented in Annex 1.

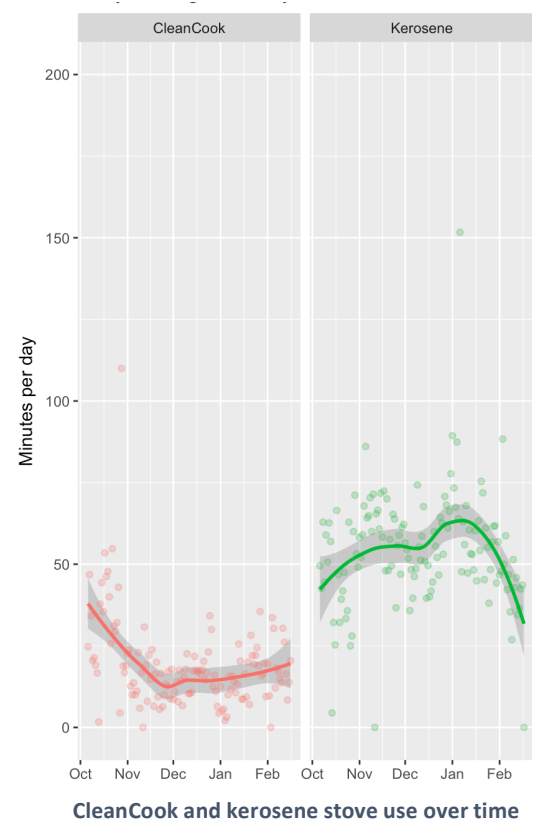
Key Findings

Key results are presented below, while the complete set of findings is presented in Annex 1.

Stove Usage

Stove use monitor (SUM) and self-reported data show usage patterns that suggest consistent but incomplete adoption of the CleanCook stove.

- ❖ 4-5 months after receiving the stove, 65% (n=17) of participants reported that the CleanCook was the stove they 'used most of the time.' Six of these homes reported to use it exclusively.
- ❖ Just over one-third of participants (38%, n=10) reported to use their CleanCook stove 7 days per week, with most of these (90%, n=9) using it for 2 or more meals.
- ❖ Self-reported data appears to over report CleanCook stove usage. SUMs results showed the overall highest average cooking events per day was on the kerosene stove (1.26, SD=0.88). The CleanCook (n=28) and the LPG (n=5) stoves, were used on average 0.72 (SD=0.58) and 0.53 (SD=0.39) times per day, respectively.
- ❖ The kerosene stoves also had the highest average minutes of use per day (93 minutes, SD=73) followed by the CleanCook (26 minutes, SD=20) and then the LPG stoves (19 minutes,



SD=16)¹.

- ❖ SUMs data from the CleanCook over the course of the study shows that usage was relatively consistent after the initial 'honeymoon' period (see figure), though kerosene continued to be the predominant fuel used.
- ❖ Homes that purchased the CleanCook after the study concluded (n=10)² showed a more intensive pre-purchase CleanCook usage pattern than those that decided not to buy: 0.87 events (SD=0.49) and 31 minutes (SD=20) of cooking per day versus 0.63 events (SD=0.63) and 23 minutes (SD=20).
- ❖ Stove use data showed no change in the use of the CleanCook stove before and after purchase (p=0.76)

Emissions and Climate Impacts

- ❖ Based on the amount of cooking done on the CleanCook, during the study, determined by SUM data, study homes were estimated to reduce their long- and short-term climate emissions by approximately 15 to 20%, as measured by carbon dioxide-equivalent and black carbon-equivalent, respectively.
- ❖ The bulk of the climate-forcing emissions came from the production and use of kerosene, as this was the primary fuel used even after the CleanCook was introduced into the households.
- ❖ If households were to switch entirely to ethanol/methanol stove use, then it is estimated they would reduce their carbon dioxide-equivalent and black carbon-equivalent emissions by approximately 70 and 80%, respectively, suggesting substantive climate impacts could be achieved with more complete displacement of current cooking technologies in urban Nigeria.

Participant perceptions of the CleanCook Stove

- ❖ 4-5 months after receiving the CleanCook stove, all participants stated that they would recommend the stove to friends and family.
- ❖ The most liked features as well as the most significant challenges reported by users are presented below.

Most liked characteristics of the CleanCook stove (n=26)	
Less smoke	17
Cooks fast	13
Keeps kitchen clean	12
Looks modern	5
Challenges experienced with the CleanCook stove (n=26)	
No significant challenges	8
Fuel does not last	6
Fuel is expensive	4
Fuel purchase is difficult	4

¹ Note: the LPG stove sample size is very small, meaning the results should be interpreted with caution. Homes with high LPG use were excluded from the study by design as we did not seek to collect data on LPG users.

² These homes had taken part in the full experimental arm of the study and had either purchased as part of the willingness to pay (WTP) exercise or after the study had finished.

CleanCook fuel access and affordability

- ❖ Percent of participants agreeing or disagreeing with statements related to the perceived usability of the CleanCook fuel are presented below.

	Strongly agree	Agree	Disagree	Strongly disagree
I can afford to cook with CleanCook fuel (n=25)	36% (9)	64% (16)	0% (0)	0% (0)
CleanCook fuel is a safe fuel to cook with (n=26)	58% (15)	39% (10)	4% (1)	0% (0)
CleanCook fuel is a clean fuel to cook with (n=26)	61% (16)	39% (10)	0% (0)	0% (0)

- ❖ Fuel canisters were sold at an average rate of 2.3 canisters per household/month. This rate provides approximatively one-third of the estimated amount of fuel that a typical Lagos household requires to meet all their cooking needs.
- ❖ 58% (n=15) reported that fuel canisters were not always available when needed, although only 4 participants said this had happened more than once over the duration of the study. When canisters were unavailable, participants cooked with a different stove.

Willingness to pay for the CleanCook stove

- ❖ A willingness to pay exercise was conducted with 37 households. 94.6% (n=35) were interested in purchasing the stove.
- ❖ Participants were told that the stove was 'worth' N24,000 (the approximate factory price), but they could purchase it for a discounted N19,000. If this offer was declined, participants were invited to make up to three bids for the stove, with any bid over N15,000 being accepted.
- ❖ 30% (n=11) purchased the CleanCook stove at an average price of N15,909 (SD 1300).
- ❖ Participants with higher levels of education were more likely to purchase the CleanCook stove (p=0.02). There was no relationship seen with other possible predictors such as current LPG ownership, age, or home-ownership status.



Conclusions and Program Learnings

Taken together, the multiple approaches used in this assessment generate an encouraging picture of ethanol as a likeable and affordable household fuel.

The ethanol-methanol cooking experience delivered sufficient benefits to the participants that they were willing to continue to procure the fuel even though the purchase experience was sometimes inconsistent and challenging.

Even with incomplete household adoption and continued cookstove stacking, an ethanol-methanol initiative could deliver significant regional reductions in climate-damaging pollutants.

Monetizing the climate benefits through some form of carbon finance to subsidize the capital cost of the cookstove would help it better compete with LPG and other cooking fuel options.

The findings of the PEDUCCT study, while rich and interesting in their own right, are limited in their scope due to the fact that only an experimental study could be undertaken during the timeframe of the research contract.

The full market launch of the CleanCook stove, which would have allowed for the evaluation of an authentic customer experience, was delayed indefinitely due to challenges with permitting and constructing the fuel supply storage and blending facilities. This deferral further underscores the challenges of trying to assess customer satisfaction with the fuel procurement system, which is central to adoption of the CleanCook in an urban market-based program, before the actual supply chain has been established.

In this case, where only the study stoves use the fuel type and the fuel can only be purchased from limited sources, canister refill data appears to be a cost-effective and reasonably accurate way to measure adoption.

Unlike self-reported data, canister sales are not affected by recall or over-reporting biases. The canister refill data provides a good counterpoint to survey data that is much less invasive and labor-intensive than stove use monitoring.

Project Context

The Project Gaia/SNEPCo initiative is motivated by an overarching social responsibility goal to “promote a safer cooking system in Nigeria as part of efforts to encourage access to a better source of energy” (SNEPCo, 2015). It builds on a recently completed randomized controlled study in Nigeria that transitioned pregnant women from traditional cooking fuels to ethanol and demonstrated improved pregnancy outcomes in mothers and children (Alexander et al., 2017; Alexander et al., 2018; Dutta et al., 2017; Northcross et al., 2016; Olopade et al., 2017). The commercial pilot also offers the opportunity to explore alternatives to methane gas flaring, which poses health and environmental risks in the Niger Delta, and support the government of Nigeria’s interest in displacing biomass and kerosene as primary household.

References

- Alexander, D., Northcross, A., Wilson, N., Dutta, A., Pandya, R., Ibigbami, T., ... Olopade, C. O. (2017). Randomized Controlled Ethanol Cookstove Intervention and Blood Pressure in Pregnant Nigerian Women. *American Journal of Respiratory and Critical Care Medicine*, 195(12), 1629–1639. <https://doi.org/10.1164/rccm.201606-1177OC>
- Alexander, D. A., Northcross, A., Karrison, T., Morhasson-Bello, O., Wilson, N., Atalabi, O. M., ... Olopade, C. O. (2018). Pregnancy outcomes and ethanol cook stove intervention: A randomized-controlled trial in Ibadan, Nigeria. *Environment International*, 111, 152–163. <https://doi.org/10.1016/j.envint.2017.11.021>
- Dutta, A., Brito, K., Khrastova, G., Mueller, A., Chinthala, S., Alexander, D., ... Olopade, C. O. (2017). Household air pollution and angiogenic factors in pregnant Nigerian women: A randomized controlled ethanol cookstove intervention. *Science of The Total Environment*, 599–600, 2175–2181. <https://doi.org/10.1016/j.scitotenv.2017.05.130>
- Northcross, A., Shupler, M., Alexander, D., Olamijulo, J., Ibigbami, T., Ana, G., ... Olopade, C. O. (2016). Sustained usage of bioethanol cookstoves shown in an urban Nigerian city via new SUMs algorithm. *Energy for Sustainable Development*, 35, 35–40. <https://doi.org/10.1016/j.esd.2016.05.003>
- Olopade, C. O., Frank, E., Bartlett, E., Alexander, D., Dutta, A., Ibigbami, T., ... Ojengbede, O. (2017). Effect of a clean stove intervention on inflammatory biomarkers in pregnant women in Ibadan, Nigeria: A randomized controlled study. *Environment International*, 98, 181–190. <https://doi.org/10.1016/j.envint.2016.11.004>
- SNEPCo, Shell Nigeria. (2015, November 9). SNEPCO PROMOTES (M)ETHANOL CLEAN COOKSTOVES IN DRIVE FOR SAFER COOKING METHOD IN NIGERIA. *2015 Media Releases*. Retrieved from <https://www.shell.com.ng/media/2015-media-releases/snepco-promotes-methanol-clean-cookstoves.html>