Wilson, D. L., Coyle, J., Kirk, A., Rosa, J., Abbas, O., Adam, M. I., & Gadgil, A. J. (2016). "Measuring and Increasing Adoption Rates of Cookstoves in a Humanitarian Crisis." *Environmental Science & Technology,* 50(15), 8393–8399. http://doi.org/10.1021/acs.est.6b02899

Research Summary

Cooking is an essential part of human life. However, 40% of the world still cooks with smoky traditional solid, mostly biomass, fuels. Exposure to smoke from such cooking can be harmful to human health and the environment. To address this, "clean cookstoves" have been developed and promoted to reduce the dangerous emissions emitted during cooking. One such cookstove is the Berkeley-Darfur Stove. Potential Energy, a nonprofit spinout from Lawrence Berkeley National Lab, has distributed more than 46,000 Berkeley-Darfur Stoves in Darfur, Sudan.

A persistent and significant problem facing most clean cookstove programs is that implementers don't have objective ways to monitor and evaluate whether their cookstoves are *actually being adopted* (i.e., being accepted and in routine actual use) after distribution on a large-scale. With this in mind, this paper presents objectively-measured data about cookstove adoption using sensors, and compares that sensor data with user-reported data (on which agencies have commonly relied so far).

Data was collected in the Al-Salam Internally Displaced Persons Camp near Al-Fashir, North Darfur, Sudan from Darfuri families that have been displaced by conflicts in Darfur since 2003. For this study, 180 women participated. Each was given a cookstove and told that they were equipped with sensors to monitor temperature, but were not told that these sensors would be used to track cooking behavior. At the beginning of the study, each participant took a baseline survey and was given a follow-up survey four to twelve weeks later, depending where they lived in the camp. At the first follow-up survey, women were classified as either users or non-users based on their sensor-measured use of the cookstove. Those who used their cookstove more than 10% of ownership days before the follow-up survey were considered users and those who didn't were considered non-users. This was an arbitrary distinction that was used to generally group people who tried out the cookstove and those who rarely did or never used the cookstove.

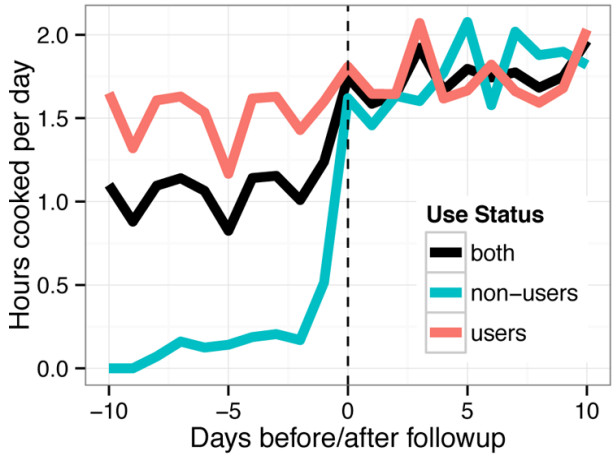

Figure 1

From the data collected, initial adoption of the cookstoves seemed strong with 71% of participants being classified as users before the follow-up survey. Perhaps even more participants would have been classified as users, but 29 cookstoves sensors were damaged when women chose to flip the Berkeley-Darfur Stove upside down and cook with the bottom filled with charcoal (an interesting insight in and of itself). Figure 1 demonstrates that non-users mostly did not use their cookstoves until 2 days before the follow-up survey. Researchers posited that perhaps this was due to social pressure or the desire to test the cookstove for themselves before being asked questions about it. Interestingly, after the follow-up survey, the non-user group continued to use the cookstoves with 83% of non-users becoming "post-followup users" and making the total amount of participants as users increase to 86% post-followup. In fact, the behavior of prior non-users after the follow-up was indistinguishable from users.

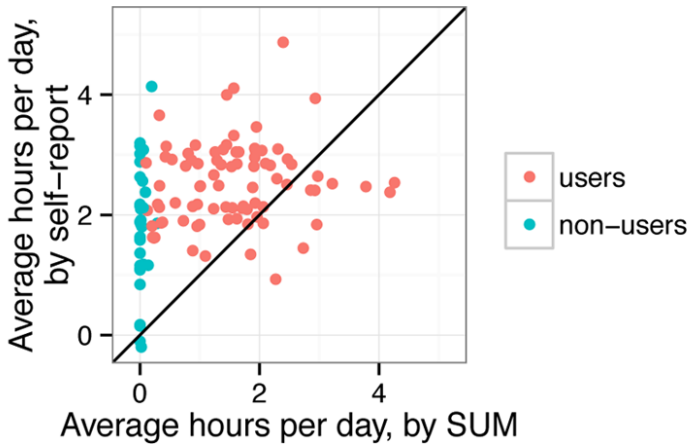

Figure 2

Figure 2 shows that on average, participants self-reported twice as much cookstove usage compared to their sensor-measured use. These overestimates were significant and weakly correlated with sensor

data. Even while trying to account for errors in estimating how often they used the stoves, it seemed that the participants intentionally overestimated how much time they used the stoves.

In conclusion, this research article highlights the differences between self-reported and sensor-detected and sensor-measured stoves usage, showing the importance of sensor data for accurate measurement of technology adoption as was done for cookstove usage. The researchers also demonstrated how the follow-up survey prompted non-users to try out the stoves and continue using them thereafter. This is a useful programmatic insight for Potential Energy and others promoting adoption of improved cookstoves. They could incorporate a follow-up visit with all recipients of the improved cookstoves to increase adoption rates. With better monitoring and evaluation techniques, technologies like improved cookstoves can become more widely adopted and successfully provide intended benefits to customers.