Beyond Monitoring and Evaluation:

TRACKING IMPROVED COOKSTOVE ADOPTION CONTINUOUSLY AND OVER TIME TO ACHIEVE LASTING SUCCESS

INTRODUCTION:

Nearly 3 billion people in low- and middle-income countries rely on traditional cookstoves fueled by biomass, such as wood and dung, to cook and to heat their homes. Traditional cooking leads to high levels of household air pollution (HAP), including black carbon, which contributes significantly to climate change. Exposure to smoke from HAP causes 3.8 million premature deaths each year, including more than 1 million deaths in India. **Improved cookstoves** (**ICS**) that leverage fuels such as pellets and other biomass, electricity, and liquefied petroleum gas (LPG) are cleaner alternatives. Sadly, low uptake of ICS by intended users has blocked progress in the sector. A variety of barriers impede clean cookstove adoption, including stove designs that fail to meet the needs of rural women, limited financing options, equipment that is not user-friendly, a lack of after-sales service at the last mile, and a market model that is not sustainable for rural energy entrepreneurs.

We can't fix problems we can't see. **If we do not track adoption of improved cookstoves continuously over time, stakeholders have little to no insight into ICS performance, user acceptability, or when design solutions are required to address these barriers.**

No one stakeholder can solve this problem. Rural women, designers, manufacturers, distributors, implementers, financial institutions, and donors need to work in concert to build lasting solutions that will work. But we need a focused goal, and that requires a continuous, shared understanding of where we are in our progress toward achieving that goal.

As part of the Nexleaf Joint Learning Program, this report, co-authored with Tata Trusts (and supported by Qualcomm® Wireless Reach™), aims to outline a framework that will help stakeholders work together to deliver clean cooking solutions that women will adopt over the long term, ultimately displacing traditional cooking. With data on usage from both ICS and traditional cookstoves (TCS), we show that ICS usage fluctuates over time, and we demonstrate that continued engagement with users after installation can lead to high, sustained ICS adoption.

We thank all our partners for building these learnings together and letting us share them here.

QUALCOMM Wireless Reach™ NEXLEAF ANALYTICS TATA TRUSTS

SUMMARY OF OBJECTIVES

In Part 1 of this report, we:

A. establish that ICS adoption fluctuates over time, **and therefore continuous stove usage monitoring offers insights that time-limited data collection cannot**;

B. suggest the **ICS adoption rate** for the entire user group as a metric to measure the health of a clean cooking intervention;

C. demonstrate that a **data-enabled clean cooking intervention**, in which a field team is reviewing ICS usage data and following up with users, can result in high sustained ICS adoption over time;

D. show that a high ICS adoption rate for a user group can indicate that traditional cookstoves are being used less (displaced);

In Part 2, we highlight use cases from individual households in which both ICS and TCS are monitored to characterize key **ICS usage patterns** and suggest useful terms.

PART 1: WHAT WE GAIN BY TRACKING ICS ADOPTION OVER TIME

HOW IMPROVED COOKSTOVE ADOPTION FLUCTUATES OVER TIME

With ongoing data from automated monitoring throughout the lifetime of the ICS, clean cooking implementers can see how cookstove usage fluctuates over time. With an engaged field team, implementers can better understand the reasons for these fluctuations. Field teams with access to ICS usage data can provide users with timely support as they transition to cleaner cooking technologies.

Data in this report comes from StoveTrace monitoring from 127 households from the following clean cooking projects:

Group 1: Odisha, India (52 households) monitored from April 2017 to July 2018. Users receive climate credit payments for their ICS usage.

An engaged field team reviews household stove usage data regularly and takes action when usage drops, providing support for users in their transition to the ICS.

Group 2: Gujarat, India (20 households) monitored from September 2016 to July 2017. This group received field team support, with special attention on sustaining the pellet fuel supply for the ICS.

Group 3: Odisha, India (55 households) monitored from November 2014 to June 2015. This was a low field support implementation, in which stoves were distributed and users were left mostly alone. Findings from this project were published in the peer-reviewed journal *Nature Climate Change*.

Unsustained ICS Adoption

Figure 1 (right) shows the ICS adoption rate over time across one of the groups. In this case, women took out loans to purchase stoves, which were distributed with StoveTrace sensors in order to calculate climate credit payments to women. However, StoveTrace data was not viewed or used in real time to support the implementation, and individual users received only sporadic after-sales service or follow-up for their stoves. In April 2015, climate credit payments began, which boosted adoption briefly.

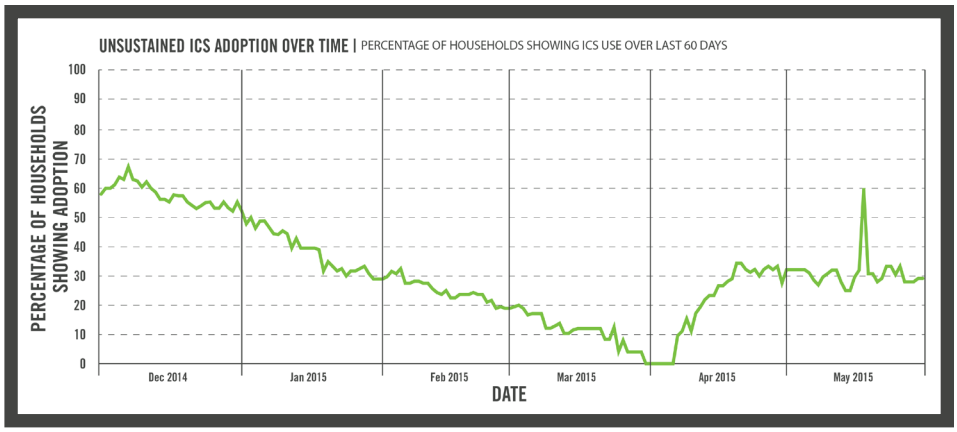

FIGURE 1: Unsustained Adoption Over Time

Sustained ICS Adoption

Figure 2 shows that a different group is faring well, and that most users are adopting the ICS and continuing to use the ICS over time. The **ICS adoption rate** for this group remains high, mostly above 90%, as compared with group in Figure 1, which experienced a decline in the adoption rate.

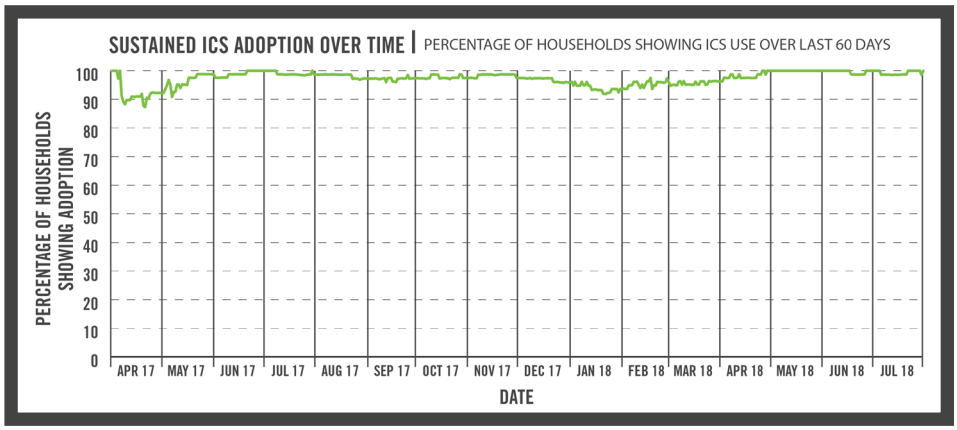

FIGURE 2: Sustained Adoption Over Time

The **ICS adoption rate** is the percentage of households in a population that cook on the improved cookstove at least 1 hour per day on average over the most recent 60 days. This is a useful measure of the overall health of a clean cooking project. We view this metric as **the heartbeat of a clean cooking implementation**. In Figure 1 above, the mostly steady decline in the ICS adoption rate demonstrates that this project did not result in long-term ICS usage for most households.

While we don't have usage data from TCS for this group, we can assume from the declining ICS adoption rate – as well as from a reduction in the number of houses sending data over time – that households reverted to relying primarily on traditional cooking practices.

Of course, clean cooking deployments are often large, and it is not always possible to follow up with each individual. However, as Figure 2 shows, by tracking ICS adoption across the whole population over time, stakeholders can detect when a clean cooking implementation begins to fail. This provides the opportunity to conduct targeted feedback with individuals in order to: 1) **get timely, data-supported feedback** from stove users on why they've stopped using the ICS; 2) provide stove manufacturers with feedback to improve stove designs; 3) determine if users need training or other support to increase their usage of the ICS; 4) evaluate the durability of an ICS, and whether there is sufficient maintenance, after-sales service, and logistical support required for clean cooking success.

HIGH ICS ADOPTION ACROSS A GROUP MAY INDICATE THAT TCS ARE BEING DISPLACED

We've shown a group's high ICS adoption rate over time (Figure 2). We also documented low average TCS usage across the group for the same time period. Figure 3 shows the percentage of households from Figure 2 using each type of stove on any given day, averaged by month. Although tracking ICS usage cannot prove TCS displacement in any individual household (see Part 2), achieving high ICS adoption over time co-occurred with the elimination of TCS usage across a majority of households in this group.

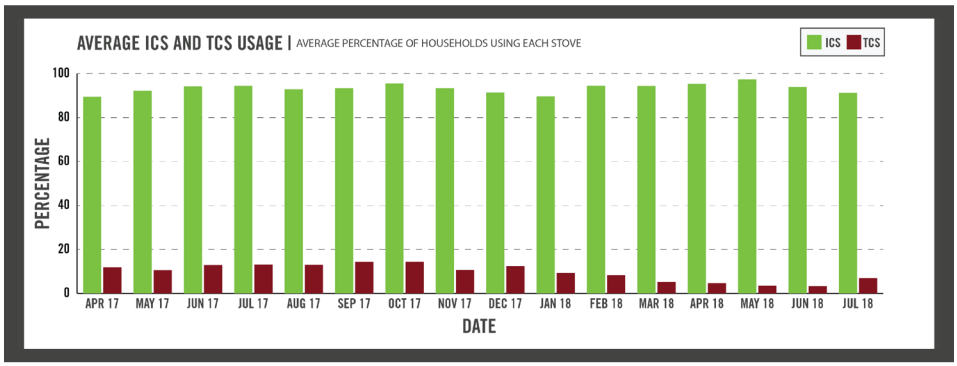

FIGURE 3: Average ICS and TCS Usage

PART 2: CHARACTERIZING ICS AND TCS USAGE DATA FROM REAL HOUSEHOLDS

HOW WE CAN CHARACTERIZE AND IMPROVE ICS USAGE

Examples from real households featured below illustrate the relevance of the selected definitions and the thresholds used in this evaluation. Each plot represents a single household, and each data point represents a day of cooking, with green dots indicating minutes of cooking on the ICS that day, and the red triangles indicating minutes of cooking on the TCS that day.

Please note that the data range in question is approximately six months (September 2017 to March 2018) for one group of households; the range varies for other household groups. **These data snapshots are not intended to show outcomes.** We are showcasing them because they typify specific stove usage scenarios we want to share from these unique data sets, in which both improved and traditional stoves were monitored. In the service of anonymity, we have given pseudonyms to the women stove users.

Find the matrix of ICS and TCS usage thresholds we explored and how each of the 52 households in one group fared at nexleaf.org/reports/adoption_matrix.pdf. This matrix helps demonstrate why we selected **at least 1 hour of ICS cooking a day on average over the most recent 60 days** as the threshold for ICS adoption.

High ICS Usage

Below is over 14 months of side-by-side ICS and TCS stove usage data from a real household, **Aditi Household**, consisting of 3 family members.

Aditi's data shows cooking on both stoves, but it shows increased reliance on the ICS over time. Her average ICS usage fluctuates from just under 1 hour per day (58 minutes) at its lowest, to over 2 hours per day (125 minutes) over the most recent 60 days of data. She does not use her TCS at all in the most recent 60 days. Her level of ICS usage meets the standard of cooking 1 hour or more on the ICS per day on average over the past 60 days.

It was found during follow-up surveys that Aditi's initial challenges adopting the ICS came from having cooked on the TCS since her childhood. As the primary cook of her family, she also relied on the TCS's large capacity when cooking unthreshed rice (paddy), which is a seasonal activity. However, after attending demonstrations of the ICS in her village and learning how she could earn climate credits for her ICS usage, Aditi shifted her cooking practices to rely on the ICS more. Over a period of time, her concern for the safety of her child around the fire in the TCS prompted her to stop using the TCS completely. As pictured in Figure 4, Aditi currently uses her TCS for storage of kitchen items.

FIGURE 4: Image of Aditi using her TCS as storage.

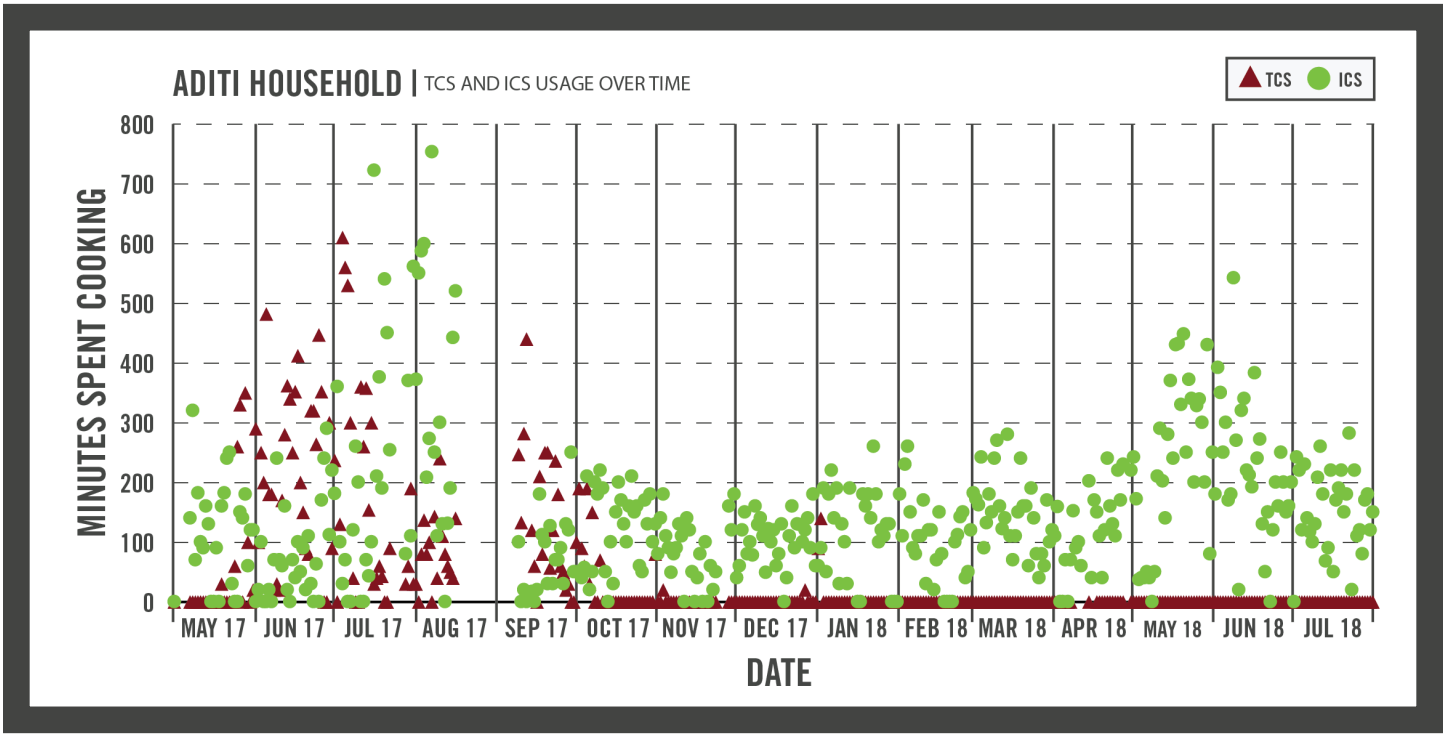

FIGURE 5: Aditi Household showing *high ICS usage*.

Stacking & Alternating

At the start of this data exploration, we hoped to find a metric for ICS usage that could serve as a proxy for TCS disuse. Was there a minimum amount of cooking on the ICS that always correlated with the household abandoning their TCS?

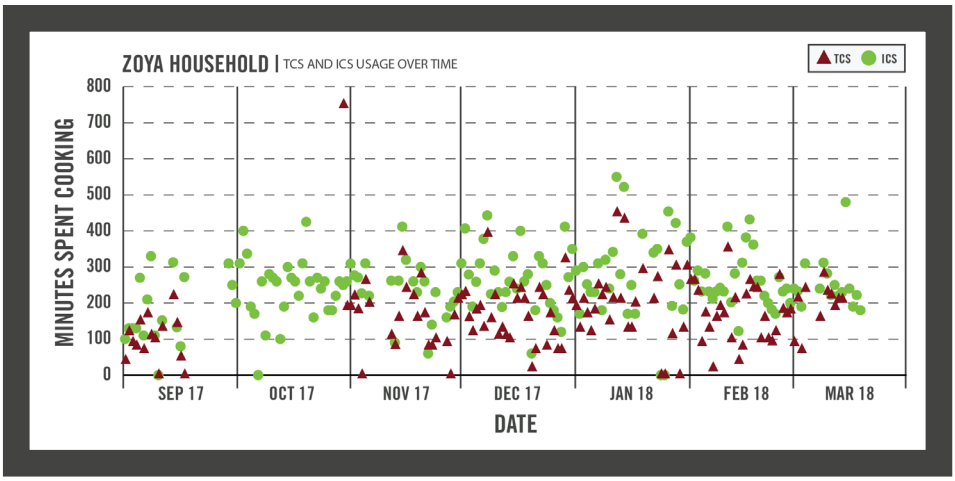

FIGURE 6: Zoya Household showing *stacking* and *alternating*.

We hypothesized that users cooking at least 3 hours a day on the ICS would not be using their TCS anymore at all. **Zoya Household** meets this high bar and cooks 260 minutes on the ICS every day on average (over the most 60 days of data). However, despite being a high ICS user, she is clearly still using her TCS as well. Closer analysis revealed that Zoya is *stacking* as well as *alternating*, meaning she uses both the ICS and the TCS on some days (stacking), and also uses each type of stove alone on some days in the most recent 60 days of data.

In analyzing the entire group, we concluded that for an individual household TCS displacement *cannot* be inferred from the ICS usage, even when objective sensors are used in place of surveys to monitor ICS usage. However, as indicated above, while on an individual basis ICS usage does not imply disuse of TCS, across a group we found that high ICS adoption rates corresponded to low use of TCS. Different households cook different daily total amounts and frequencies, and some households have high total cooking. We found no clear correlation with family size in this group.

TCS Displacement

Conversely, we also found that some households with what we would have *previously* considered to be low ICS cooking had, in fact, stopped using the TCS. **Aruna Household** is one such example.

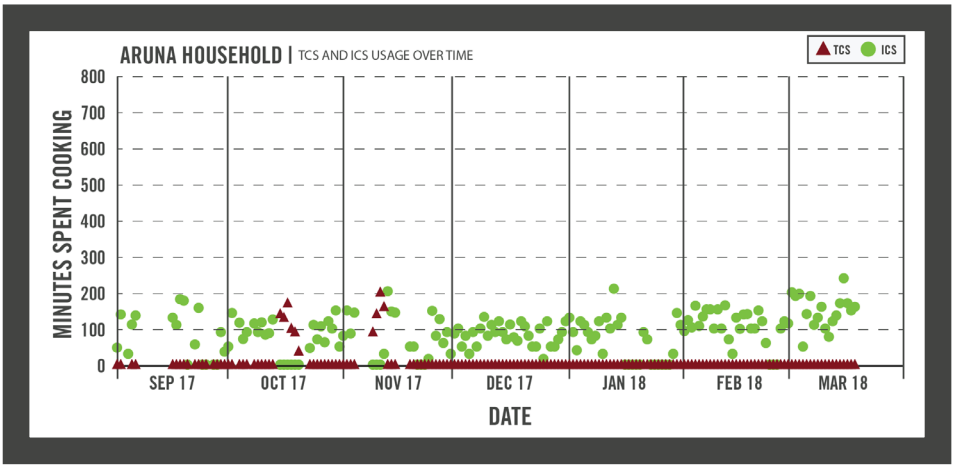

FIGURE 7: Aruna Household showing *TCS displacement*.

Aruna cooks on the ICS 100 minutes per day on average over the most recent 60 days. However, data from Aruna shows that the TCS is not being used at all during that same time period.

The data from Aruna illustrates how data from a limited sample time period, for instance, the first 15 days after installation, **is not sufficient to establish or disprove the sustained usage of an ICS**. Examples like this one are why we limit the definition of TCS displacement to the most recent 60 days of data.

LOW ICS USAGE

The average ICS usage for **Ekta Household** is 7 minutes per day over the most recent 60 days of data, falling far short of the 1-hour average per day required to be considered ICS adoption. This is a *low ICS usage* household.

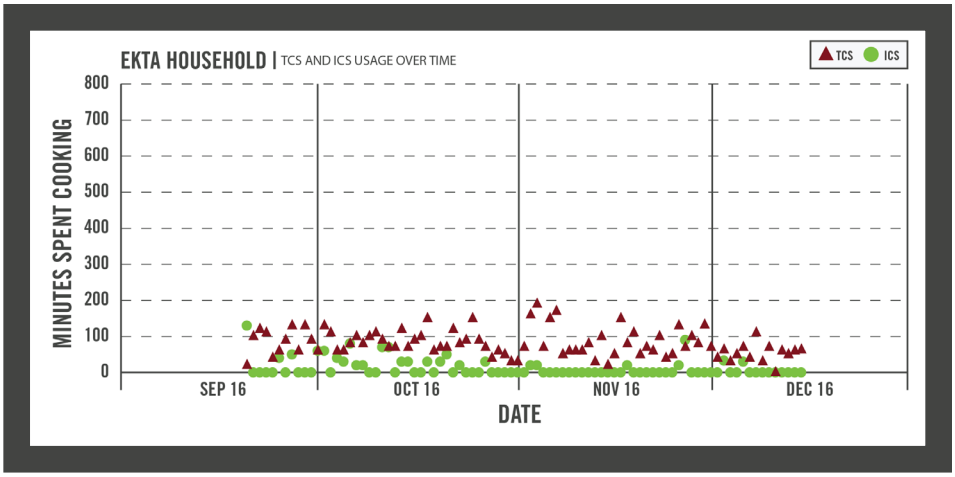

FIGURE 8: Ekta Household showing *low ICS usage*.

WHERE DO WE GO FROM HERE?

The Value of Tracking ICS Adoption Over Time

In our past work in monitoring households in India with Qualcomm® Wireless Reach™, we have documented several barriers to clean cooking success based on qualitative follow-ups to our data. These barriers include poorly-designed ICS that are too inconvenient to use, too polluting, or break too easily; seasonal changes in cooking demands; and a lack of after-sales service and support for new ICS users.

We suggest that **ongoing ICS usage monitoring in households** is a way to raise alarm bells that a barrier has interrupted the user's successful transition to ICS cooking. A field team armed with household usage data can follow up with individuals when their ICS usage drops, intervene to fix the problem, and document any issues that need to be addressed at other levels of the program.

Continuous household usage monitoring enables implementers to track the **ICS adoption rate** for any clean cooking project. The ICS adoption rate is meaningful for:

- **Clean energy implementers** seeking to build successful cookstove interventions;
- **Stove manufacturers** committed to providing usable, durable stoves with adequate after-sales support;
- **Financers** invested in clean cooking outcomes; and
- **Governments and multinationals** pledging to reduce emissions from household smoke.

KEY TERMS AND DEFINITIONS

From our analysis of data from households, we therefore define the following term in order to support objective assessments of the health of an intervention across all households:

- **ICS Adoption Rate:** Percentage of households in a population that cook on the improved cookstove at least 1 hour per day on average over the most recent 60 days.

Additionally, we define the following terms to categorize individual household cooking behavior:

- **TCS Displacement:** No use of the traditional cookstove in the most recent 60 days of data.
- **Low ICS Usage:** Less than 1 hour of ICS usage per day on average over the past 60 days.
- **Alternating and/or Stacking:** Usage of the ICS and the TCS that occurs on the same day(s) (stacking), or on different days (alternating) in the most recent 60 days of data.

Determining TCS Displacement

Across the group presented in Figure 3 (page 4) the high ICS adoption rate does correspond with low daily TCS usage. However, this data set also shows that high ICS usage does not imply that the TCS is no longer used in a given household. Monitoring the TCS to show disuse can be difficult and costly. So how can implementers determine whether clean cooking projects are resulting in TCS displacement?

An engaged field team can document proxies that, when combined with ICS usage data, provide evidence of TCS displacement. For examples, some users remove the TCS from the household altogether. Other users repurpose the TCS as storage, as we see in the Aditi Household (page 5).

Ultimately, air quality analysis may be necessary for determining the impact of a clean cooking project. However, tracking the ICS adoption rate and documenting proxies for TCS displacement are clearly key steps along the path to achieving clean cooking success.

THE NEXT CHAPTER

The next few briefs in this series will share learnings from a multi-partner evidence driven study in India, being supported by Tata Trusts and Qualcomm® Wireless Reach™, in collaboration with Nexleaf Analytics and partners, to study the drivers and barriers of clean cooking adoption from an empirical understanding.

ABOUT NEXLEAF ANALYTICS: Nexleaf Analytics is a mission-oriented organization committed to mobilizing data to create positive environmental and health impacts and be useful every day. Nexleaf provides sensor-based data collection, analytics, visualizations, and web dashboards for data advocacy to improve both the understanding and the execution of clean energy interventions. We gather, analyze, and present data to serve local communities every day and to align stakeholders around common information so that intractable problems can finally be solved. In the cookstove sector, as data and analytics specialists, we have tested assumptions, documented challenges and failures, and developed a proven methodology for adaptive and scalable solutions.

Nexleaf's flagship technology StoveTrace is a cloud-based remote temperature monitoring system for cookstoves in rural and off-grid households and has been deployed in numerous household in India with Saunta Gaunta Foundation (SGF). StoveTrace continuously uploads data on cooking events on an improved cookstove (ICS); it can simultaneously monitor usage of a traditional cookstove (TCS) as well. Together, Nexleaf and SGF have shown that ICS adoption is possible. Learn more at www.nexleaf.org/cookstoves.

ABOUT TATA TRUSTS: With a legacy of over 125 years, Tata Trusts is India's oldest, non-sectarian philanthropic organisations that works in several areas of community development. Through direct implementation, co-partnership strategies, and grant making, the Trusts has played a pioneering role to support and drive innovation in the areas of education, healthcare and nutrition, rural livelihoods, natural resources management; enhancing civil society and governance and media, arts, crafts and culture.

In the last few years, the Trusts have been implementing a clean cooking program in India with the objective of building an enabling ecosystem for rural communities to access affordable, clean and efficient cooking solutions. The program was launched to foster demand and facilitate the supply of efficient cooking solutions at the doorsteps of the rural and tribal communities through their community institutions and local entrepreneurs, and drive adoption of cleaner cooking solutions. Learn more at www.tatatrusts.org.

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