SUPPORTING INFORMATION

Patterns of stove usage after introduction of an advanced cookstove: the long-term application of household stove usage sensors

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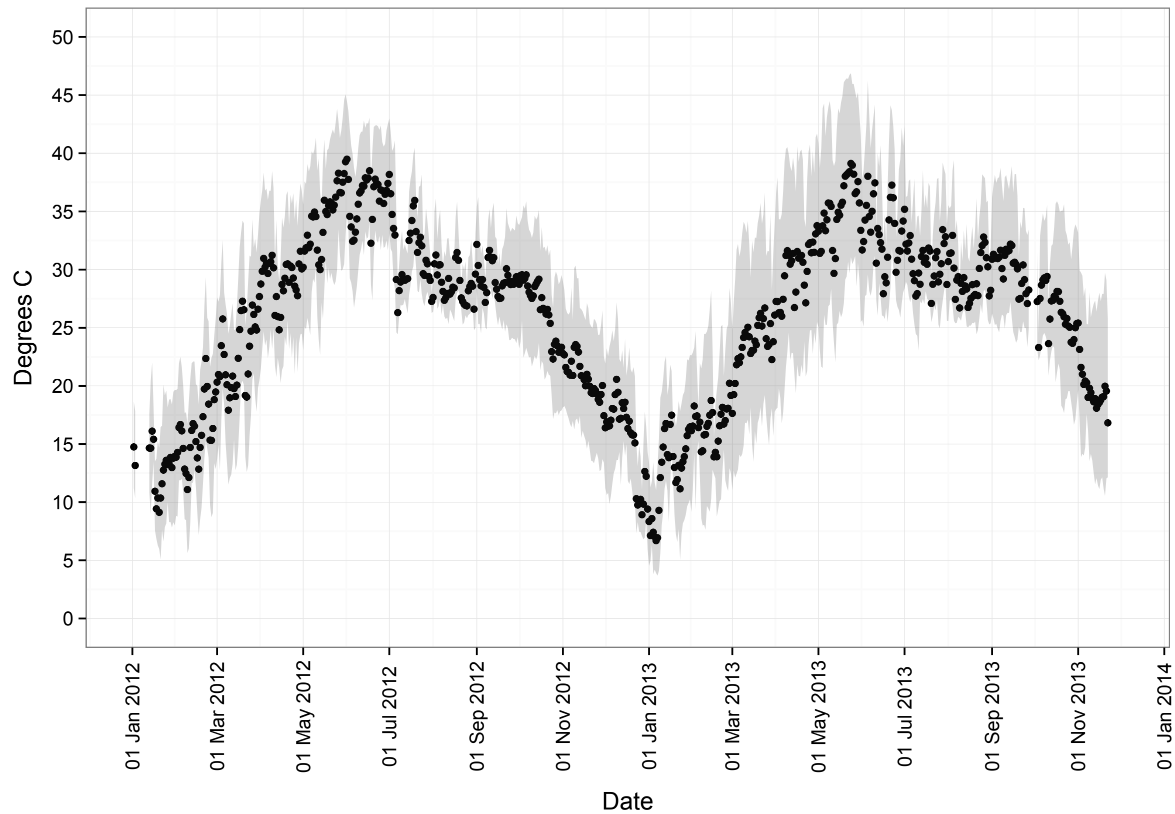

Figure S1. Ambient temperatures at International Clinical Epidemiology Network's headquarters, in Palwal, Haryana, India. Dots are daily mean temperatures; shading at each point represents the range between the daily minimum and maximum.

Counts of Stove Usage. A commonly reported metric of stove usage is the number of stove use events per day. These raw counts can be considered independently or can be aggregated into "meals" based on knowledge of cultural practices. In the current study, we evaluated the number of discrete events occurring within 40 minutes of each other; for example, two temperature peaks detected at 12:30 and 12:55 would be counted as a single event.

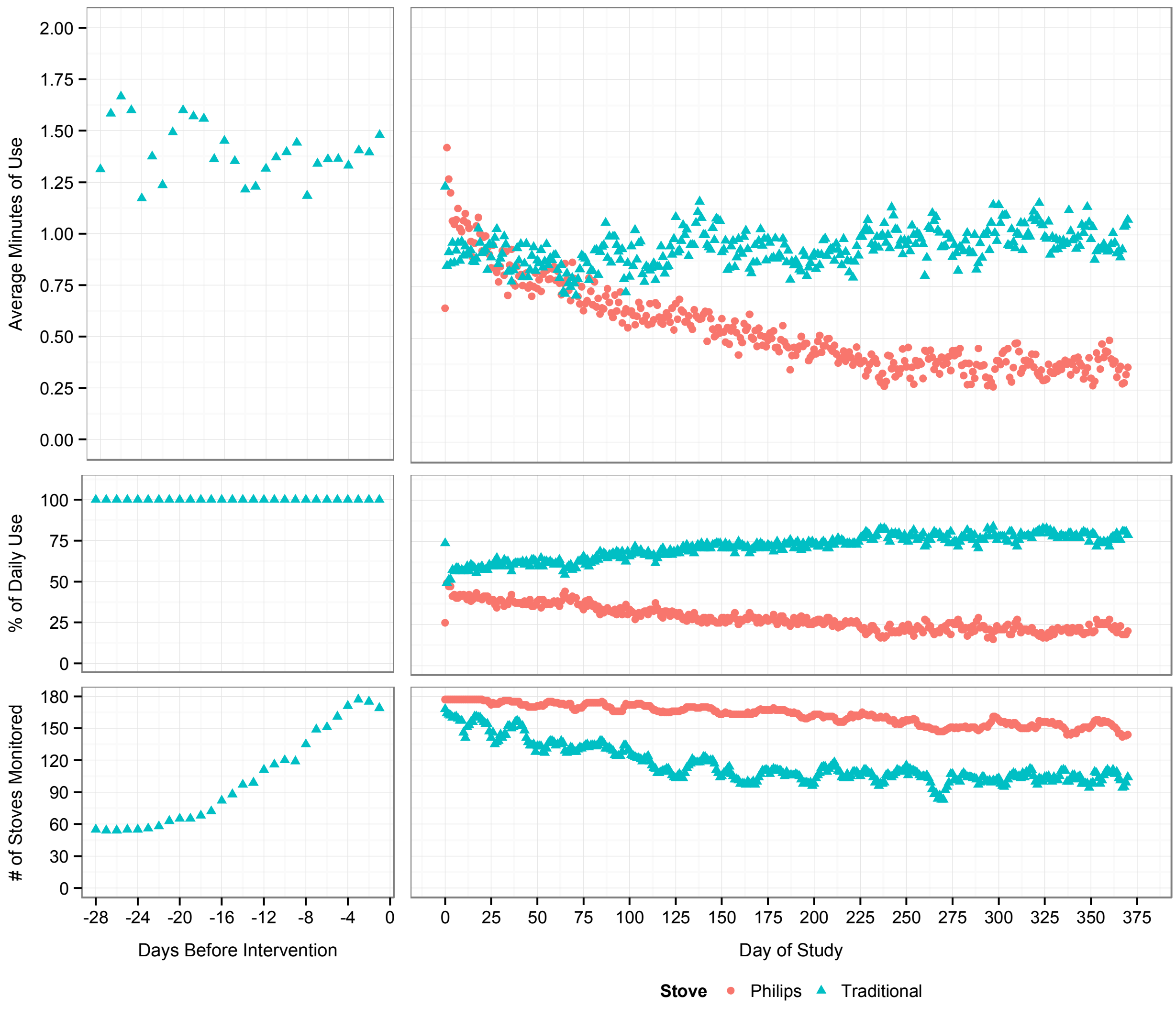

Figure S2. Counts of use of traditional and intervention stoves throughout study. The upper panel depicts daily mean number of uses of monitored stoves by stove type. Day 0 is the day the intervention stove was introduced. The middle panel depicts the percent of stove use events for each stove. The bottom panel depicts the number of stoves monitored per study day.

Trends in event counts over time follow those reported in the main text for durations of use over time. During the initial days and first week after deployment of the Philips, we note use of both stoves, indicating a period during which the Philips was evaluated by households for applicability. Use of the traditional stove remained relatively constant after introduction of the Philips. On average, prior to the introduction of the Philips, traditional stoves were used 1.4 times (SD = 0.8) per day. After introduction of the intervention, average usage of the traditional stoves decreased to 1 time per day; the Philips was used 0.6 times per day. While trends in use of the traditional stove were relatively stable post-intervention, Philips use decreased linearly. While event counts are useful for tracking adoption, they fail to capture duration of use, which we believe to be a more useful metric.

Restricted analysis. Due to missing data from both the traditional and intervention stoves, we performed the same analysis described in the main text on days for which we had data on both the traditional and intervention stoves (n = 49,279 days). Trends mirrored those reported in the main text and are summarized in Table S1 and Figure S2.

Table S1. Study means of post-intervention use from the restricted and full analyses.

	Mean (SD) (minutes, restricted analysis)	Mean (SD) (minutes, full analysis)
Traditional	145.7 (134.1)	143.9 (133.6)
Philips	64.87 (88.3)	60.0 (86.8)

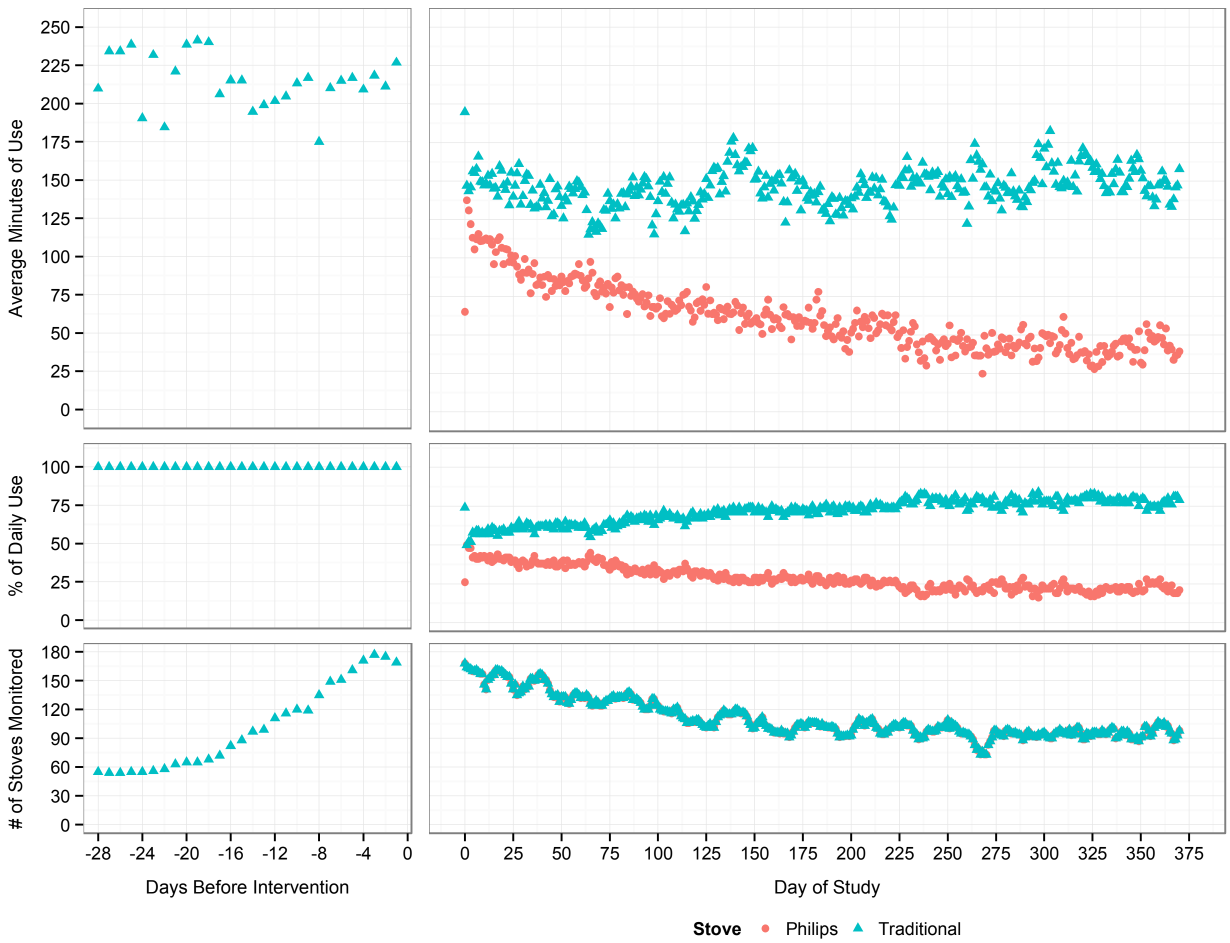

Figure S3. Use and monitoring of traditional and intervention stoves throughout study, restricted to days for which valid data was present for both stoves. The upper panel depicts daily mean usage of monitored stoves by stove type. Day 0 is the day the intervention stove was introduced. The middle panel depicts the percent of stove use time each stove was used. The bottom panel depicts the number of stoves monitored per study day.

Trends for utilized cooking energy (UCE) in this restricted analysis followed patterns shown in the main text and are depicted in Figure S3 and Table S2.

Table S2. Study means of post-intervention UCE from the restricted and full analyses.

	Mean (SD) (MJ, restricted analysis)	Mean (SD) (MJ, full analysis)
Traditional	10.7 (0.9)	10.6 (0.9)
Philips	6.1 (2.1)	5.9 (2.0)
Total	16.8 (2.1)	16.5 (2.0)

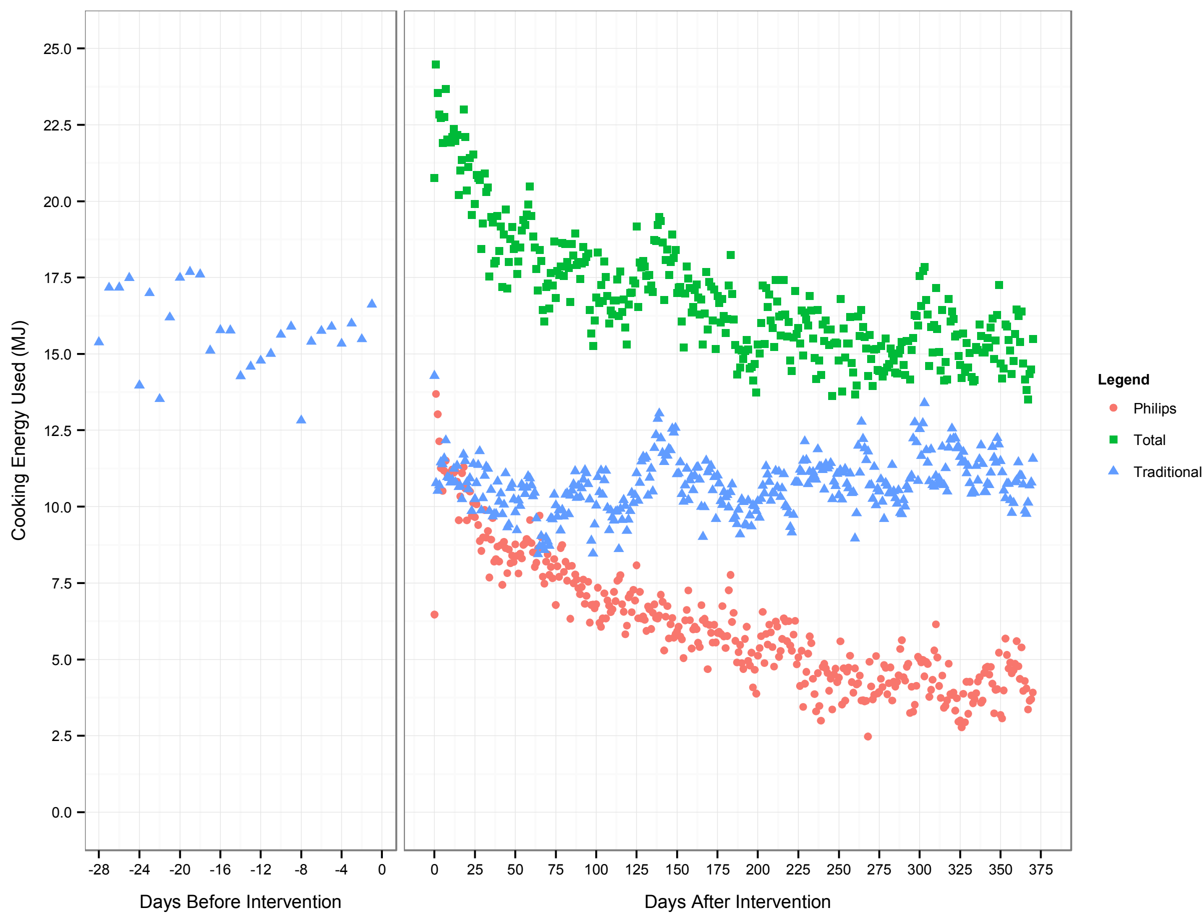

Figure S4. Utilized cooking energy in megajoules throughout intervention for the restricted dataset. The utilized cooking energy is presented separately for the traditional and intervention stoves (blue triangles and red squares, respectively) and pre and post-intervention periods. The total energy use is presented in green squares.

Table S3. Daily usage duration means and intraclass correlation coefficients

	Mean (minutes) per day (95% Confidence interval)	Intraclass Correlation (95% CI)
Traditional		
Pre-intervention[a]	209.2 (205.4 to 212.9)	0.25 (0.20 to 0.30)
Post-intervention[b]	143.9 (142.7 to 145.2)	0.35 (0.30 to 0.41)
Philips[c]	60.0 (59.3 to 60.7)	0.22 (0.18 to 0.25)

95% confidence interval in parentheses

[a] 2958 stove days from 177 homes

[b] 44448 stove days from 177 homes

[c] 63433 stove days from 177 homes

Optimizing SUMs sampling strategies

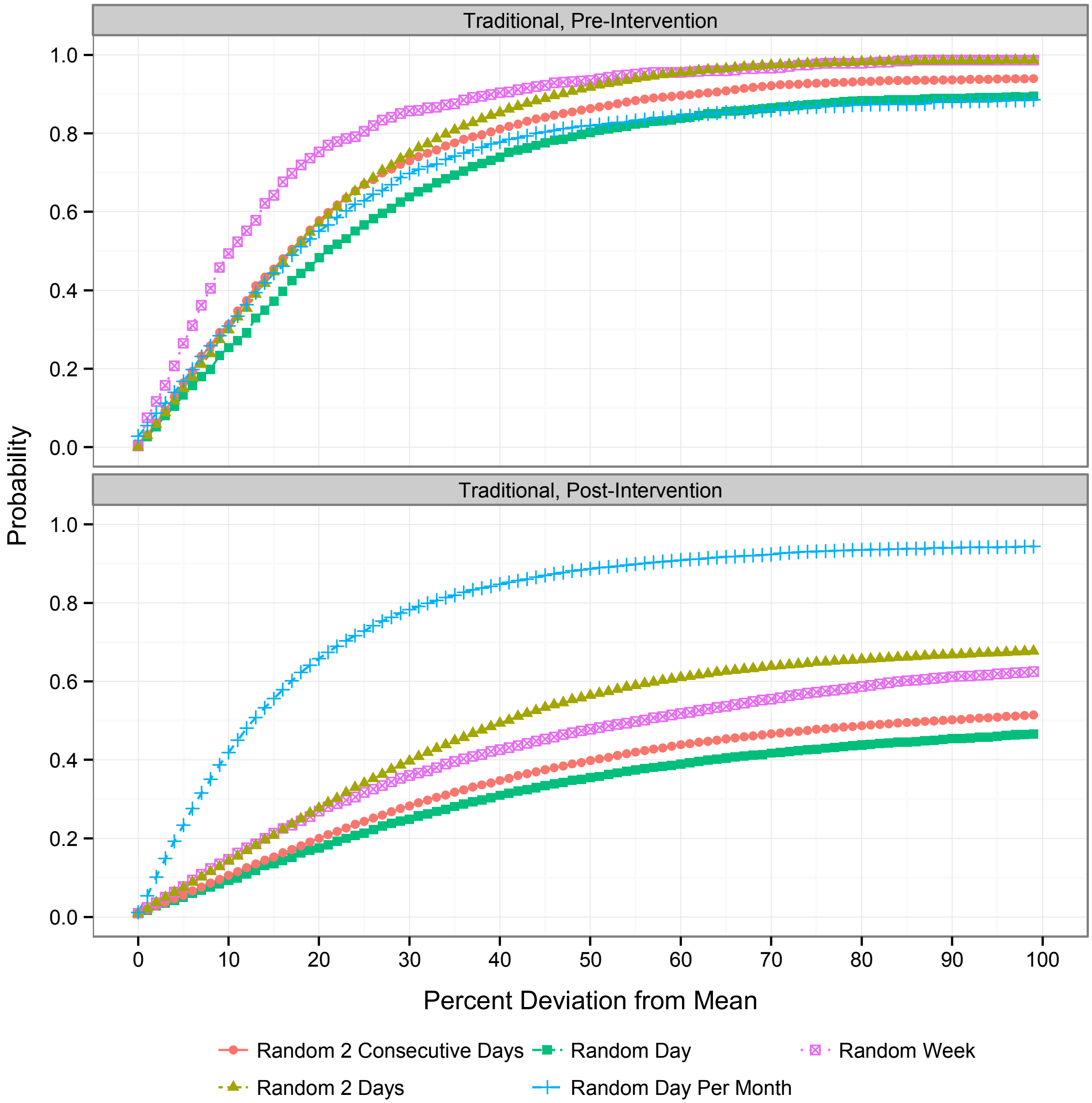

Figure S5. Optimizing measurement strategies for SUMs sampling. The upper panel shows the precision of various short-term measures of use of the traditional stove prior to introduction of the intervention; the bottom panel shows the precision of short-term measures of use of the traditional after introduction of the intervention.

Table S4. Probability of obtaining usage estimates within 20% of study mean

	Pre-Intervention Traditional Stove	**Post-Intervention** Traditional Stove
Single Day	0.48	0.18
Two Consecutive Days	0.58	0.20
Two Non-consecutive Days	0.57	0.28
Random Week	0.75	0.27
One Day per Study Month	0.55	0.66

Maintenance and repair of Philips stoves. Field staff visited homes every two weeks to download data from SUMs. During these visits, they observed stove performance and recorded findings. A total of 1387 stove observation visits were recorded. Between visits, participants could call field staff to report issues with the Philips or bring malfunctioning units to study headquarters. Study staff attempted to perform repairs on broken stoves; if they were unable to fix the stove, trained technicians were hired. A small supply of replacement stoves was available to supply homes with continual service throughout the study period.

Stove failures were categorized into 9 categories: battery failures, printed circuit board (PCB) failures, charger failures, knob failures, cracked or shattered plastic base, fan failures, internal plates cracked, broken, or collapsed; top of stove corroded, and other. Of the stoves distributed, 142 had at least one failure that resulted in a repair. The mean time to first failure was 171 days. Failure types are summarized in Figures S4 and Table S3.

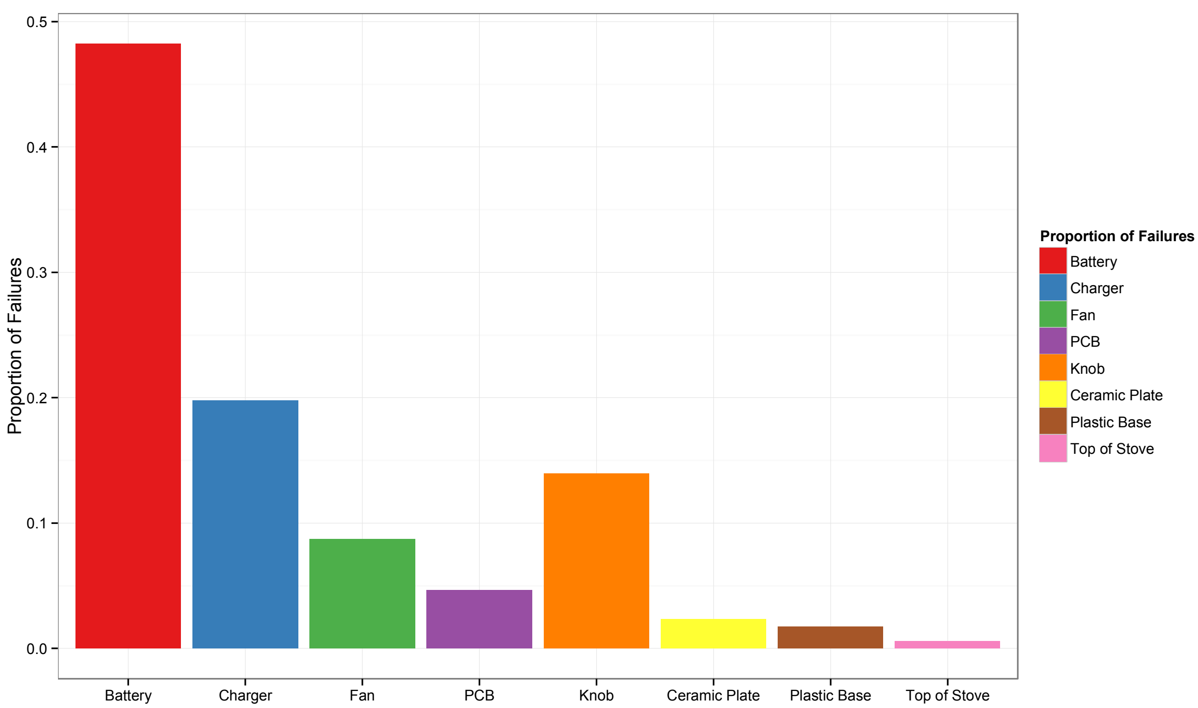

Figure S6. Counts of first failures of Philips stoves.

Table S5. Summary of failures observed during fieldworker visual inspection of Philips stoves.

Fuel Chamber (cracked)	**6**
Stove Body	**26**
Broken	17
Dented	9
Knob	**48**
Broken	11
Missing	1
Jammed	36
Battery & Charger	**75**
Not charging	72
Missing	3
Fan Not Working	**32**

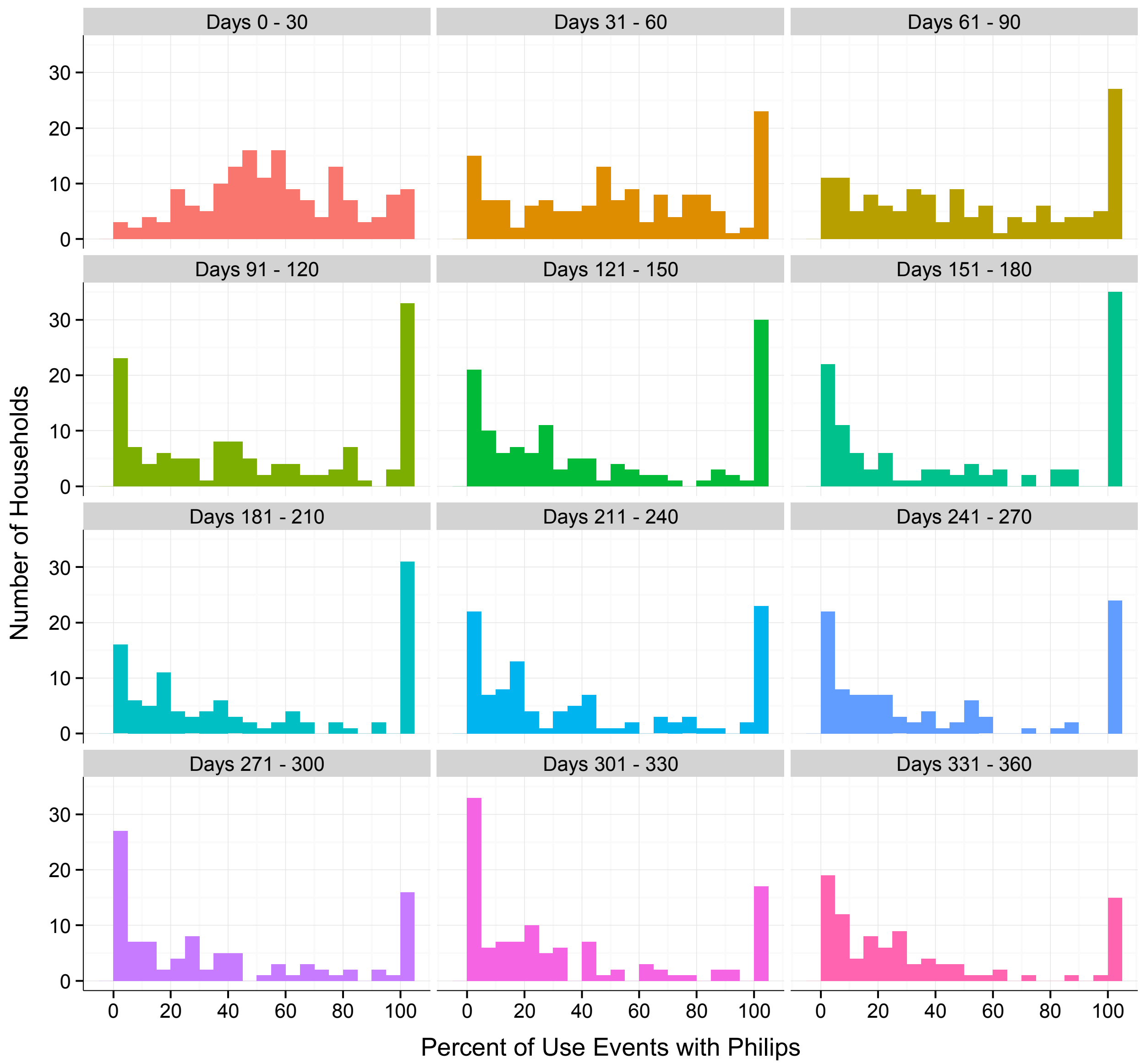

Figure S7. Percent of Use Events with Philips. Panels are 30 study days in length, denoted in the topmost gray area. Homes with no cooking are not included. Bars indicate the number of households using a stove for a corresponding period of time.

SUMs Field Performance. Field workers downloaded data from stoves 9131 times during approximately 4737 household visits. On average, each of the 200 households was visited 22.8 times. Of the 9131 downloads, 83% yielded data (n = 7613). Figure S7 depicts the frequency of data retrieval failures by cause, including an inability to access the stove (Door Locked), damage to the SUMs from heat or water resulting in an ability to download data; data errors due to sensor malfunctioning, lost or misplaced SUMs, or SUMs that had split apart or burst due to exposure to excess heat.

Data loss impacted the traditional stoves more significantly than the intervention stoves. Traditional stoves varied widely in construction; in some households, placement of the SUMs in the ‘standard’ location resulted in either over-heating or exposure to water from cooking. We believe the wave-like pattern present in the post-intervention traditional homes (Main text, Figure 3, bottom panel) occurred because of detection of SUMs failures during household visits, which occurred in clusters at two week intervals.

We approximated the total number of data points that should have been collected during the study by subtracting the initial data collection date from the final data collection date and multiplying the number obtained in days by 144 (the number of data points collected per day). We collected 93% and 67% of the expected data for the Philips and traditional stoves, respectively.

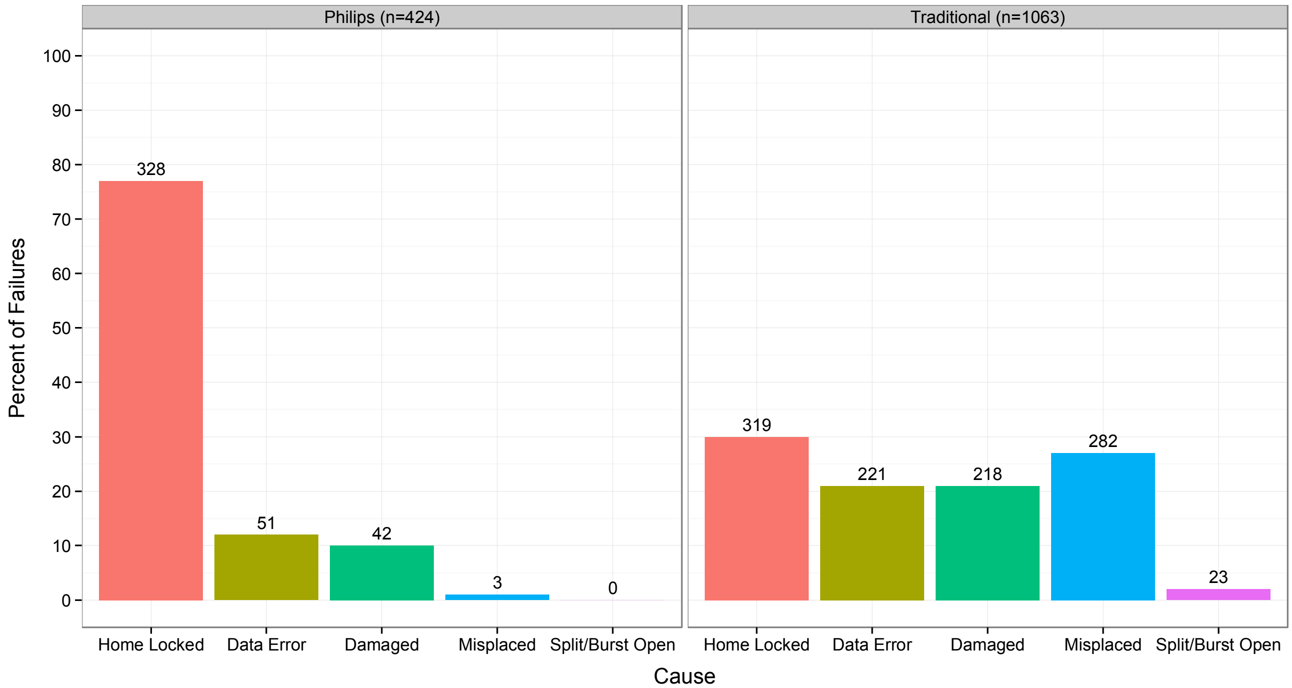

Figure S8. Stove Use Monitors data loss by cause. Numbers above the bars indicate the counts per failure type.