Reducing Fuel Stacking

A survey tool for the clean cooking industry

CLEAN COOKING ALLIANCE

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Contents

Executive Summary

This theory- and evidence-based toolkit is designed to support any organization whose remit involves understanding and changing fuel stacking behavior. Behavioral interventions are more likely to be effective if they are rooted in a comprehensive understanding of the influencing factors in a given context. Grounded in academic research, this toolkit offers a strategic appreciation of the various individual, socio-cultural and environmental influences on a household's choice of fuel. The toolkit itself consists of a survey and data analysis template (to access the templates, please email userinsights@cleancooking.org). The behavioral insights gained by applying this toolkit can be used by organizations to promote more exclusive use of clean cooking fuels and technologies.

Acknowledgements

This report was prepared for the Clean Cooking Alliance as part of the User Insights Lab by **Dr Tash Perros**, an Engineer and Postdoctoral Research Associate at the Department of Public Health, Policy & Systems at the University of Liverpool, and **Ayşe Lisa Allison**, a Behavioral Scientist and PhD candidate at the UCL Plastic Waste Innovation Hub and UCL Centre for Behavior Change. The production of the report was led by Colm Fay from the Clean Cooking Alliance and supported by Pamela Lee.

1. Introduction

1.1 Why does fuel stacking matter?

Sustainable Development Goal (SDG) 7 calls for universal access to clean fuels and technologies for cooking by 2030. However, there are currently 2.3 billion people who lack access to clean stoves and fuels, resulting in harmful health, gender, and climate impacts. Even those who do have access to clean cooking continue to concurrently use polluting fuels, such as firewood and charcoal. This practice of relying on a mixture of clean and polluting fuels is known as polluting fuel stacking and it undermines the potential benefits of clean cooking transitions.

Fuel stacking is also problematic for market-based providers of clean cooking fuels, forming a barrier to the long-term viability and productivity of such businesses. The more fuel that customers use, the more revenues providers can make, which enables their businesses to scale and bring clean cooking to wider audiences. Furthermore, stacking indirectly affects calculations involved in the Gold Standard and Verra carbon credit methodologies, such that programs with higher levels of stacking have lower carbon revenues. Reducing fuel stacking is therefore imperative to the success of businesses and, by extension, to minimize the negative health, social and environmental impacts of cooking with polluting fuels.

1.2 Who is this tool for?

This tool and accompanying guide are for enterprises and program implementers working within the clean cooking sector whose remit involves understanding and changing patterns of fuel stacking.

1.3 What gap does this tool address?

Fuel stacking occurs for a diverse and complex range of reasons. Prior to this theory- and evidence-based toolkit, non-academic enterprises and program implementers working within the clean cooking sector may have had to rely on expensive and time-intensive academic partnerships or cursory analyses to understand their customers' fuel stacking behavior. This toolkit enables these organizations to more independently, yet comprehensively, understand the various factors that are driving fuel stacking behaviors in their target populations and design interventions that are more likely to be successful at improving sustained clean fuel use.

1.4 What can I learn from using the tool?

Fuel stacking in a type of human behavior and human behavior does not occur in a vacuum; it is context specific. What may have driven fuel stacking in a specific population, technology, time, and place may not apply to the case at hand.

This tool can be used to provide valuable behavioral insights about why fuel stacking is occurring in your setting of interest. These learnings can then be used to design or refine interventions to reduce stacking that are specifically tailored to your context. Basing intervention design on a considered and comprehensive understanding of behavior in its context maximizes the likely effectiveness of that intervention at changing behavior (Kelly & Barker, 2016).

You might reasonably wonder why using the tool is better than simply asking beneficiaries why they stack. The answer is that stacking is a complex behavior that is usually influenced by a multitude of factors. A single question will elicit the top-of-mind responses (in our experience, generally issues to do with affordability and stove functionality) but fall short of exploring more complex influences. This means that interventions designed in response to the single-question approach may fail to comprehensively address the problem and therefore lack efficacy.

1.5 What does the tool consist of?

The tool itself consists of a **survey** and **data analysis template**. These tools, along with this guide, can be used to inform data collection and data analysis. Table 1 details all the documents included.

Table 1: Documents comprising the stacking toolkit.

Item	Description	Access
Survey template in Microsoft Word format	This is the raw, 'paper' version of the survey.	Please email userinsights@cleancooking.org for access
User guide	This is the current document outlining how to apply the tool to understanding fuel stacking within your customer population.	The present document

2. Development of the stacking tool

This section provides background information about how the tool was developed.

2.1 Fuel stacking taxonomy

The tool is based on a theory- and evidence-based taxonomy of fuel stacking drivers (Perros et al., 2022). The taxonomy itself was developed via a review of grey and peer-reviewed scientific literature and aggregates the diverse set of reasons why people stack across multiple countries, contexts, and technologies. The taxonomy consists of *n*=61 drivers grouped into *n*=11 categories. Table 2 below lists the full taxonomy for reference.

Table 2: Taxonomy of stacking drivers. Adapted from: Perros et al. (2022)

Category	Code	Description
AFFORDABILITY (AFF)	AFF_1	Fuel price too high
	AFF_2	Income constraints
	AFF_3	Cannot afford to buy fuel in the quantities it is sold in
	AFF_4	Fuel price changes
	AFF_5	Availability of cheaper alternative fuels
	AFF_6	Too expensive to cook certain foods on clean stove
	AFF_7	Distortions in affordability caused by subsidies
CULTURAL COMPATIBILITY (CUL)	CUL_1	Traditional stove preferred for taste
	CUL_2	Belief that it is healthier to cook on traditional stove
	CUL_3	Traditional stove necessary for ceremonial rituals
	CUL_4	Importance attached to cooking the traditional way
	CUL_5	Culturally inappropriate to remove a pot from flame whilst cooking
	CUL_6	Belief that wood smoke solidifies walls of buildings
	CUL_7	Social aspects of cooking with traditional stoves
	CUL_8	Traditional stoves preferred during festivals
END USES OF TRADITIONAL STOVES (END)	END_1	Wood smoke is used to preserve meat and fish
	END_2	Space heating
	END_3	Space lighting
	END_4	Wood collection is an important source of income
	END_5	Wood smoke keeps insects away

	END_6	Embers and ashes from traditional stove are used in cooking
EQUIPMENT COMPATIBILITY (EQU)	EQU_1	Clean cooking device cannot be used with large pots
	EQU_2	Clean cooking device damages traditional pots
STOVE FUNCTIONALITY (FUN)	FUN_1	Broken equipment
	FUN_2	Customers do not know how to fix and maintain equipment
	FUN_3	Lack of local technicians to fix and maintain equipment
	FUN_4	Lack of access to spare parts
	FUN_5	Stove use minimized to avoid damaging stove
HOUSEHOLD DYNAMICS (HHD)	HHD_1	Person who cooks is usually different to the one paying for fuel
	HHD_2	Gender norms around use of cooking fuels
	HHD_3	Not all members of the household know how to use stove
	HHD_4	Safety concerns from other members of the household
	HHD_5	High labor requirement for feeding biogas digester
KNOWLEDGE AND TRAINING (KNO)	KNO_1	Low awareness of how to use stove correctly
	KNO_2	Belief certain foods cannot be cooked on stove
	KNO_3	Lack of motivation to use clean cook device
SAFETY ISSUES (SAF)	SAF_1	Fear of short-circuiting electricity in the house
	SAF_2	Fuel perceived as dangerous
	SAF_3	Fear of gas explosions
	SAF_4	Fear of burns
FUEL SUPPLY ISSUES (SUP)	SUP_1	Fuel shortages at retail points
	SUP_2	Inadequate voltage supply
	SUP_3	Lack of raw materials to produce fuel
	SUP_4	Travel cost or distance to purchase fuel
	SUP_5	Weather impacts on fuel supply
	SUP_6	Distrust in local fuel retailers
TECHNICAL CHARACTERISTICS (TEC)	TEC_1	Stove does not get hot enough
	TEC_2	Stove is physically unable to perform certain cooking tasks
	TEC_3	Difficulties controlling temperature
	TEC_4	Difficulties lighting stove

	TEC_5	Stove too small
	TEC_6	Stove produces unpleasant smell whilst cooking
	TEC_7	Stove is smoky
	TEC_8	Cannot track fuel use and therefore expenditure
	TEC_9	Stove not portable
	TEC_10	Inconvenience of fuel preparation for clean stove
	TEC_11	Difficulties reloading fuel for clean stove
TIME ASPECTS (TIM)	TIM_1	Need to cook multiple items at once
	TIM_2	Cannot multi-task whilst using stove
	TIM_3	Seasonal variation in fuel usage
	TIM_4	Stove takes too long to cook

2.2 Bboxx pilot

The survey was initially used with 99 customers of Bboxx's PAYG LPG product in Kisumu, Kenya to design an intervention reducing stacking as part of one of the author's (TP) PhD project (Perros, 2023). Learnings from this study resulted in the survey tool being revised to improve the flow, structure of items and the user experience. More details on this intervention can be found in Section 7.

2.3 MGas pilot

With support from the Clean Cooking Alliance, the revised survey was applied for a second time with 1323 customers of MGas's PAYG LPG product in Nairobi, Kenya (Perros et al., in draft.). In this study, a sample of the survey results were validated against the findings of one-on-one semi-structured interviews amongst a sample of the same survey respondents (n=18). The interviews corroborated that the stacking tool was a reliable measure of stacking drivers as identified by the fuel stacking taxonomy (Perros et al., 2022).

Consultation with MGas revealed that the survey used in the MGas pilot was too long and the analysis too intensive to be easily used by clean cooking practitioners without external assistance. Therefore, this user guide presents an abridged version of the survey that is designed to be faster to implement and analyze. Decisions about which content to cut were made as follows: 1) we reduced reliance on conditional logic and the number of branches of the survey to make it simpler to analyze; 2) we eliminated questions pertaining to very uncommon stacking drivers in the taxonomy; 3) we replaced Likert scale responses with binary ones; 4) we eliminated a section about seasonal variation in fuel use which provided interesting insights but did not necessarily relate directly to stacking; and 5) we omitted the demographic questions not directly relevant to the analysis.

3. Structure of the stacking survey

3.1 Section 1: introduction and consent

This section confirms the survey respondents consent to provide their data and confirms that their household currently cooks with the target cooking technology. You may wish to also record their customer ID and phone number to match survey responses to a particular data point to avoid duplication.

3.2 Section 2: current fuel use

This section collects data on who the main cook in the household is and asks whether the enumerator is currently talking to the main cook. If not, it is recommended to call back later to ensure you are talking to the main cook / user of the stove. This section also asks about the last time that the respondent (the main cook) cooked with a variety of fuels in their current home, which we have found to be the most efficient way of understanding the full range of the fuel stack (including fuels that are use very rarely) and gauging the frequency of use. More guidance on survey respondent sampling approaches can be found in Section 4.1.

3.3 Section 3: influences on fuel stacking behavior

This part of the survey collects data on the factors that are potentially influencing the respondent's general fuel stacking behavior. Respondents are asked whether they agree with a series of belief statements about how different factors influence their choice of fuel e.g., "*My household income is too low to exclusively use [target cooking fuel];*" "*It is better for your health to cook on traditional stoves than [target cooking fuel].* Each of these questions map directly to an item on the fuel stacking taxonomy (Perros et al., 2022).

3.4 Section 4: cooking processes

This portion of the survey investigates how different cooking processes relate to fuel stacking, giving an indication of the compatibility between the stove and local cuisine.

3.5 Section 5: specific foods

This part investigates how different foods drive fuel stacking. Respondents indicate whether they avoid cooking certain foods with the target 'clean' fuels and explain the reasons why e.g., *"Too expensive;" "Does not taste good;" "The food burns too easily;" "Stove too small to cook this."*

3.6 Section 6: final questions

This section closes the survey and allows respondents to provide additional information that may not have been captured by the survey e.g., *"Are there any other factors we have not discussed today that influence your choice of cooking fuel, if any?"; "We have spoken about lots of different reasons why you might choose to use a fuel other than [target cooking fuel] today. What is the top reason you personally do not use more [target cooking fuel]?"* If using an incentive, this is the section where you can reiterate the amount and state when it will be paid.

4. Data collection

The text below provides advice about implementing the survey tool based on learnings from the Bboxx and MGas pilots.

4.1 Sampling

This is an exploratory survey that investigates how a wide range of factors influence fuel stacking behavior. There are therefore no obvious parameters to input into a sample size calculation. The more of the target population that can be surveyed the better, as a larger sample size improves conclusiveness of findings, but this requires more time and financial resources. Here, we follow Pearson and Mundform in recommending a minimum sample size of n=100 but emphasize that larger samples are preferable if resources allow (Pearson et al., 2010).

We recommend sampling from the full study population rather than just for customers that you suspect to be stacking. This is because our experiences with MGas and Bboxx found that even customers who appear to be exclusive users based on their fuel consumption data can still be regularly cooking with polluting fuels. If you believe that there are sub-groups within your population who stack for different reasons – for example, if a substantial number of potential participants live in a colder region where space heating drives polluting fuel use - you may

want to consider a segmented approach that purposefully draws from these different groups. The minimum sample size for each group should still be *n*=100.

Based on our experiences with the MGas pilot, we believe this abridged survey should take 15-20 minutes and that one fieldworker could complete ten surveys per day. To improve reliability and validity of survey data, it is recommended that efforts are made to always talk to the main cook / user of the stove in the household.

The tool is intended as a one-off to understand stacking practices in a target population. It could also be applied at regular intervals as a continuous improvement tool to monitor changes in stacking practices and how the target cooking technology compares to alternatives in the market. If adopting the latter strategy (which has not been tested by the authors) then it may be practical to develop an abridged version of the survey that is more efficient to implement. We recommend applying the full tool in the first instance and then deleting questions that the analysis reveals are less relevant to the context.

4.2 Adapting the questionnaire

The survey is intended to be used flexibly so that it can be adapted to different contexts. You may find that some survey items in Section 3.3 are not appropriate for your application of the tool e.g., "Sometimes I avoid using [target cooking technology] because I fear cylinder explosions" may only be relevant for LPG interventions. We have used comments to flag questions that are technology specific. Where an item is deemed inappropriate, remove it. Equally, if you have a hunch about a driver of stacking that is not covered, then add it in. You may want to capitalize on the data collection opportunity and add some demographic questions to better understand the customer base. Developing the final version of your survey is an iterative process that involves working closely with your data collection team and careful piloting (see Section 4.4).

Other areas that may require adaptation include: the alternative fuel choice options in Section 3.2 of the survey, cooking processes in Section 3.4 and specific foods that drive stacking in Section 3.5. Amend, and remove where appropriate. Table 3 below provides a list of foods commonly associated with stacking across a range of countries which can be used to guide those included in your survey. These foods can also be found in the final sheet of the Excel format of the survey. If relevant, remember to remove this sheet in the version you upload to your data collection platform, e.g., Kobo or ODK, or the platform will not be able to process the spreadsheet.

Although every effort has been made to limit the length of the survey, we acknowledge that it is still long (~60 questions) and that some practitioners may wish to reduce it further. In this case, we recommend piloting the full survey with a smaller sample (at least 25 participants) to identify questions that can be cut. However, there is always a risk that a sub-sample of this size is not representative of the larger target population and that eliminating questions may lose valuable data.

Table 3: Foods that drive stacking by country. Source: Perros et al. (2022)

Country	N papers	Foods that drive stacking	Comments
EAST ASIA & PACIFIC			
Cambodia	1	Grilling meat	
China	4	Porridge, soup, steamed foods	
Timor-Leste	1	Grilling meat, grilling fish	
Myanmar	3	Curries, vegetables, beans	
LATIN AMERICA & CARIBBEAN			
Guatemala	4	Maize / corn (N = 2[1]), beans (N = 3), nixtamal, tamales, tortillas, meat, heating water	Tamales are a corn-based dough mixture filled with various meats, beans, and cheese
Haiti	2	Rice and beans, mashed breadfruit, ground corn	
Mexico	3	Nixtamal (N = 3), heating water (N = 2), beans (N = 2), tortillas, preparing animal feed, maize / corn, soups	
Nicaragua	1	Tortillas, beans, maize / corn	
Peru	7	Fava beans (N = 2), soup (N = 2), corn nuts, quinoa porridge, legumes, stews, quinoa, toasted bread, quinoa bread	
SOUTH ASIA			
Bangladesh	4	Puffed rice, traditional cakes	

[1] This refers to the number of papers finding that this food drives stacking, if greater than one.

India	12	Chapatis / rotis (N = 5), rice (N = 2), daal, pulses, heating water, preparing animal feed	
Nepal	4	Preparing animal feed (N = 3), chapatis, meat, heating water (N= 2)	
SUB-SAHARAN AFRICA			
Cameroon	2	Ugali / fufu	
Ethiopia	5	Injera (N = 2), coffee (N = 2), porridge, bread	
Ghana	9	Tuo zaafi (N=3), banku (N=2)	Tuo zaafi is a millet / maize porridge. Banku is a white paste made from fermented corn and cassava.
Kenya	13	Githeri (N = 4), chapatis (N = 3), beans (N = 2), green peas (N = 2), ugali (N = 2), cowpeas, maize / corn, meat, leafy vegetables, pancakes, pilau, stews, heating water	
Malawi	5	Beans, heating water	
Mozambique	2	Beans	
Nigeria	4	Preserving meat and fish (N = 2), cassava flour, soup, beans	
Rwanda	2	Beans, cassava	
South Africa	3	Samp, bones, bread, beetroot, potatoes	Samp consists of dried corn kernels that have been pounded until broken but not finely ground
Tanzania	4	Githeri / makande (N = 2) Loshoro, rice, ugali, beans,	Loshoro is a traditional drink made by mixing boiled maize with curd. Makande is a stew of kidney beans, maize and spices. It is the same as githeri in Kenya.

			Ugali is a type of maize or cassava flour porridge.
Uganda	5	Matoke / plantain (N = 3), ugali, beans,	Matoke is a variety of banana
Zambia	5	Beans (N = 2), visashi, fresh fish, water heating, nsima	Nsima is like ugali but made from other types of flour e.g., millet. Visashi (or ifisashi) is a traditional dish prepared with spinach and peanuts

Another important consideration is translation. What language(s) do your target population speak best? Once you have finalized the content of your survey, the questions and potential answers should be translated into as many languages as is required by native speakers.

4.3 Mode of data collection

The mode of data collection constitutes another important decision about implementing the survey. Will the survey be conducted face to face by an in-person fieldworker, via telephone by enumerators or online for people to fill out via their own devices? These decisions have different implications for data collection and are highlighted in Table 4.

Table 4: Considerations for different data collection approaches

Consideration	Face-to-face via in-person fieldworker	Telephonic surveys with enumerators	Online survey for people to fill out via their own devices
Human resources	Requires higher human resources. Fieldworkers need to be trained. Human resource load can depend on the survey interface e.g., load is likely to be significantly less if responses are directly collected on a tablet or other device vs	Requires moderate human resources. Fieldworkers still need to be trained but less resources are involved in getting fieldworkers to data collection locations. Data can easily be downloaded for analysis afterward.	Requires lowest human resources as the survey links are sent to participants for completion. Data can easily be downloaded for analysis afterward.

	"pen and paper." If directly inputting data into the survey on a tablet, data can easily be downloaded for analysis afterward. Collecting data via "pen and paper" will be resource intensive as it will take more time to input, clean, and prepare data for analysis.		
Survey platform	Could use a "pen and paper" approach or a data collection platform such as Google forms, ODK or Kobo and have that on a tablet where the fieldworker directly inputs the data.	A data collection platform such as Google forms, ODK, or Kobo where the enumerator directly inputs the responses from the survey responses over the phone.	A data collection platform such as Google forms, ODK, or Kobo where the survey respondent directly answers on their own electronic device.
Survey interface	Improving the user experience will need to focus on the enumerator as they are the user in this scenario e.g., providing effective prompts	Improving the user experience will need to focus on the enumerator as they are the user in this scenario e.g., providing effective prompts	Improving the user experience will need to focus on the survey respondent as they are the user in this scenario e.g., no jargon, simple language, minimal skip logics, survey as short as possible
Social desirability bias	Risk is higher as, in person, desire to look to others more likely to be present	Risk is moderate as over the phone, desire to look to others may still be present but likely to be less so than if in person	Risk is lower as can be completed anonymously and without being "seen"

Completion rate	Likelihood of higher completion rates owing to lack of anonymity	Likelihood of moderate completion rates as there is still a lack of anonymity but less so than if face-to-face	Likelihood of lower completion rates in comparison owing to anonymity
Convenience for the survey respondent	Least convenience as more less flexible on the time and location of participant during data collection	Moderate convenience as more flexibility on the time and location of the participant during data collection	Highest convenience as most flexibility on the time and location of the participant during data collection
Incentives	Can be more or less the same regardless of data collection format e.g., voucher / credit sent to phone number which would be linked a customer ID	Can be more or less the same regardless of data collection format e.g., voucher / credit sent to phone number which would be linked a customer ID	Can be more or less the same regardless of data collection format e.g., voucher / credit sent to phone number which would be linked a customer ID
Sampling approach	Sampling may need to be more purposeful to avoid bias e.g., at different time points and locations to minimize participant bias e.g., are these people who would have more leisure time than the general population?	Random sampling can be used. Participants can be reached via text / email. Stratified approaches could be taken if differences in stacking due to, for instance, geographic location is anticipated. A stratified approach followed by a random sampling approach within the strata could be followed.	Random sampling can be used. Participants can be reached via text / email. Survey links could be sent via customer phone numbers. Stratified approaches could be taken if differences in stacking due to, for instance, geographic location is anticipated. A stratified approach

			followed by a random sampling approach within the strata could be followed.
Respondent access to technology	Less of an issue as the fieldworker brings their own technology	Less of an issue as the survey respondent need only have access to their phone which does not need to be a smart phone	Potentially more of an issue as survey respondents would need to have access to a survey compatible personal electronic device such as laptop, smartphone or tablet which might exclude some customers

For the MGas study in Nairobi, we used trained enumerators to conduct telephonic surveys. Prior to data collection, MGas messaged their customers asking for explicit permission to share their contact details with our team. The enumerators then called the expectant customers, obtained verbal consent to participate, and read out the survey questions. The enumerators entered their responses into an online data collection tool (see Section 4.4). below for more details). We opted for telephonic surveys because they are cheap and convenient for the participants, however, other approaches have their own merits. Conducting the surveys in-person can improve participant engagement and result in higher completion rates. It is up to you to decide on the most appropriate, practical, and resource-efficient for your implementation context.

The survey mostly collects quantitative data, and we recommend using a data collection platform or app to capture it. There is a wide range of options available, each offering different functionalities and payment plans. We recommend using Kobo, or Open Data Kit (ODK), both of which include the following features that are key to this survey: programmable logic that allows some questions to appear if certain responses to others are selected; good quality web and mobile user interfaces; downloadable data in Excel format; response validation via data types; and an offline submission feature. At the time of writing, Kobo is free, whereas ODK incurs a small charge. The advantage of ODK is that it has additional data privacy features and user support. You can read more about the differences between ODK and Kobo here, watch a

video introducing ODK here and an overview of Kobo here. Both ODK and Kobo use the same Excel-based input to generate the questionnaire, and a copy of this input has been provided as part of the tool. We have also provided a Google form version of the survey for further convenience.

4.4 Enumerator training and questionnaire piloting

If you opt for the enumerator route, it is ideal that they are familiar with the clean cooking product and have prior experience conducting surveys. They should be unknown to the respondent so ideally avoid using technicians to avoid creating a social desirability bias. Social desirability bias is a type of response bias in research. It is the tendency of survey respondents to answer questions in a manner that they think will make them be perceived more favorably by others. It can take the form of over-reporting desirable behavior for that context, e.g., exclusive clean fuel use, or under-reporting undesirable behavior for that context, e.g., engaging in stacking.

Training should take between 1-2 days depending on how experienced the fieldworkers are and should cover the following aspects:

- **Motivation for the study**: it is important that the data collection team understand the rationale behind the study as it will help them interpret responses correctly and probe respondents appropriately, leading to higher quality data
- **Familiarization with the data collection instrument:** this involves training the team on how to use the technology of choice (e.g., Kobo, Google forms) and walking them through the survey, ensuring they understand each question properly. This is a good opportunity to catch translation errors and to tweak the wording of questions, so they are easier to understand
- **Role plays:** The data collection team should be split into three. They should take turns to practice the survey on each other, with one fieldworker observing and taking notes. The groups of three should share feedback directly with each other to help improve their survey style. They should also make notes of any suggested changes to the survey that emerge at this stage, which should be fed back to the wider group and implemented before the next phase of training
- **Piloting:** The data collection team should be split into pairs and take it turns to practice the survey on a real respondent, with the counterpart listening in. Again, the idea is to generate feedback that can be shared with each other and the group to improve performance and refine the survey questions

The training PowerPoint used in the MGas study has been shared in the Appendix for reference.

4.5 Participant recruitment

The introduction section of the survey includes a placeholder question for the enumerator to introduce themselves. We have included some suggested text, but we understand that different organizations have different standards for doing this. At minimum, we advise that the fieldworker introduces themselves by name; explains the reason for the call; states how much of the participants' time is required and if they will receive some compensation for their time. We recommend tracking the calls on a spreadsheet to record if a call back at another time is required or if a customer does not wish to take part and therefore should not be called again.

Providing a small incentive can help to improve the response rate, reduce response bias (where only engaged customers wish to participate) and to compensate the participant for their time. On the other hand, they also risk coercing customers into taking part. Incentives should be appropriately sized – not so large as to oblige people to take part, but not so small that they are insulting. At the end of the call, we recommend clearly explaining when the incentives will be paid in order to manage participants' expectations.

5. Data analysis

An automated Excel analysis tool for the survey is provided along with this guide. It produces a host of graphs to describe the data and understand dominant drivers of stacking (including radial stacking diagrams). Instructions on how to use it can be found in the "NOTES ON USE" tab of the spreadsheet. Any item additions or omissions to the Google Forms and Excel survey templates should be reflected in the analysis tool accordingly as this analysis tool is only compatible with the version of the survey templates provided in this toolkit.

Further analysis can be conducted by joining the survey results to other already-existing data about the customer. Examples of possible analyses include:

- Conducting a logistic regression of customer fuel consumption data with the stacking drivers they experience to identify the drivers that have the largest influence on fuel use.
- Combining with customer demographic data to gain more granular insights into the target customer base and improve understanding of the customer mix required for a high-quality portfolio.
- Combine with both data sets mentioned above to create algorithms to identify customers stacking for specific reasons and administer relevant interventions.

6. How to use the results

The findings can be used to either design a new intervention from scratch or refine an existing intervention. Implementing intervention can be resource-intensive and organizationally challenging, so we recommend only targeting a small number of the most prevalent and addressable stacking drivers.

There are various behavior change intervention development frameworks, such as the Behavior Change Wheel (Michie et al., 2011, 2014), which can be applied to inform the intervention development process. Published examples of the Behavior Change Wheel applied to intervention design can be found online e.g., (Allison et al., 2022; Perros et al., 2023) - these resources offer templates, with guidance, to help systematically guide the intervention design process. Further guidance on applying these behavioral science principles to intervention decision making can be found elsewhere (for example here and here). Ultimately, it is important that any intervention design targets the behavioral factors identified as stacking drivers in that context.

7. Applying this tool to intervention design: a success story

The Bboxx intervention pilot mentioned in Section 2.2, exemplifies the merits of taking such a tailored approach (Perros et al., 2023). In this study, the toolkit was used to understand fuel stacking behavior amongst 99 customers of Bboxx's pay-as-you-go (PAYG) LPG product. The results showed that, for this context, stacking was most often driven by preferences for cooking specific foods on charcoal. More specifically, participants reported that it was too expensive to cook long-boiling foods on LPG, such as beans and githeri (a Kenyan bean and maize stew), and that the LPG stove tended to burn chapatis.

These findings were subsequently used to design an intervention aimed at displacing residual charcoal cooking with PAYG LPG using an established behavior change intervention development framework, the Behavior Change Wheel (Michie et al., 2011, 2014). The resulting intervention consisted of the co-provision of non-stick pans for cooking chapatis (to address the burning issue) and pressure cookers for preparing beans and githeri (to improve the efficiency of cooking these foods on LPG) along with training on how to use them. An intervention evaluation revealed an increased use of PAYG LPG and decreased use of charcoal, with a third of participants stopping using charcoal altogether. Different models of intervention provision were considered, and even fully subsidized pans yielded a positive return on

investment over a three-year period. An open-access copy of the paper containing the full results and analysis can be seen here.

Other than the Bboxx study, as of 2023 there is an absence of published research about efforts to reduce stacking. Table 5 proposes strategies – albeit mostly untested ones - that may be helpful in addressing the taxonomy categories.

Table 5: intervention strategies for each stacking category

Category	Intervention options
Affordability	Alter fuel price/tariff; target different customer segment; change quantity fuel is sold in; provide pressure cookers or other fuel-efficient vessels for cooking; if there are false beliefs that traditional stoves are cheaper, then use demonstrations or videos to communicate an accurate comparison.
Cultural compatibility	Make design changes to the stove; educate households about the importance of clean cooking and the convenience of using the device (or partner with other parties already doing this work e.g., community health workers or NGOs).
End uses of traditional stoves	Conduct housing interventions to improve thermal properties e.g., insulation; provide incense or mosquito coils; bundle stoves with clean lighting or heating solutions.
Equipment compatibility	Provide sets of pots and pans well suited to the new stove; design larger burners compatible with large pots.
Stove functionality	Provide warranties; provide guides on troubleshooting simple technical issues; train local technicians in mending the stove; provide toll-free number to call in case of technical issues.
Household dynamics	Educate households about the importance of clean cooking and the convenience of using the device (or partner with other parties already doing this work e.g., community health workers or NGOs).
Knowledge and training	Provide user training on how to use the stove via accessible mediums (in-person is best, but other options include videos, user guides and visual aids like calendars); provide user training on how to cook foods that drive stacking with the stove.
Safety issues	Focus on safety features in stove design and effectively communicating those features to build trust; educate customers about maintenance procedures so that stove remains in a safe working condition; provide warranties to encourage reporting of safety issues; ensure that the stove environment is safe e.g. that the

	stove is used on an appropriate surface and that household wiring is adequate (e-cooking devices only).
Fuel supply issues	Consider home delivery service for fuel; design warnings before fuel runs out so that customers can proactively replenish; use state-of-the-art supply chain management practices to ensure local availability of fuel and adequate stocks are in place.
Technical characteristics	Ensure that users are involved in an iterative design process so that the stove meets their needs; provide user training on how to cook foods that drive stacking with the stove; design stove with temperature adjustment so that customers can control the speed of cooking; consider applying complementary cooking technologies (e.g. electric pressure cookers with LPG) to create a "clean stack" that fully meets customer needs.
Time aspects	Provide multiple burners or stoves; design stoves with temperature adjustment so that customers can control the speed of cooking.

8. References

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