



User-Centred Design to create sustainable cooking energy systems

A step-by-step guide to ensure high-adoption rates and sustainability



Imprint

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Registered offices:
Bonn and Eschborn, Germany

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-1115
E info@giz.de
I www.giz.de

Contact
E natalie.rzehak@giz.de
I https://energypedia.info/wiki/ESDS_Resource_Page

Authors
Christa Roth
Natalie Rzehak

Text Editing
steelecht, Offenbach/Germany

Design:
creative republic, Thomas Maxeiner Visual Communications,
Frankfurt /Germany

Photo credits/sources
© GIZ/Christa Roth & Egieryallem Ayele
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The key to sustainable cooking energy systems: User-Centred Design

Food is vital for human survival. In humanitarian or displacement settings around the world, refugees receive core relief items and food. The food rations are usually dry food items that need to be cooked to become fit for human consumption. Sometimes stoves are provided to refugees, but the development of a cooking energy system (CES), which considers both a stove and fuel access, comes often later. Hence, the problem arises that stoves provided often go unused and may even end up being thrown away, often because they don't sufficiently take into consideration the challenges of fuel access. To ensure a stove is successfully adopted by users in a humanitarian setting and fuel can be supplied sustainably, aid/development organisations can apply User-Centred Design (UCD).

The products used by people in humanitarian crisis situations, in this case a cooking energy system, need to undergo a thorough design process that takes into consideration the full cooking energy system, and which involves the end user, and the local producers in all steps. A stove that has been tested somewhere else, for example, for fuel efficiency and deemed "good", does not necessarily respond to a specific location's or user group's needs.

In protracted settings it is highly impactful if users are integrated in every step of the cooking energy system design, local value chains considered, and the process is continuously iterative with feedback loops to make improvements along the way and adjust the product to

changing needs. The result would then be a CES that is almost 100% adopted by its users and ensures the most efficient use of fuel.

The pre-conditions for implementation of UCD would be a long-term displacement situation, settlement, or camp where structures are well established, and the implementing organisation of the UCD process has been in place for several years. A highly volatile or conflict zone is not realistic. Infrastructures such as existing value chains, roads, and access to local producers are key, as well as access to available cooking fuel materials.

This article provides a guideline and the specific steps needed for a UCD process for stoves – with the aim of helping organisations and host communities to provide a cooking energy system that is sustainable and long-lasting for users.

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A step-by-step guide for displacement settings

Food is vital for human survival. The accessibility of food in humanitarian settings often relies on rations of dry food items that need to be cooked to become fit for human consumption. Thus, access to a reliable cooking energy system (CES) in humanitarian settings becomes vital for survival, for both refugees and their host communities alike.

NOT COOKING IS NOT AN OPTION.





UCD expert Christa Roth and UNHCR energy focal person Melkam Walle lead users through the UCD process in Nyunyiell Camp in Gambella Region, Ethiopia.



1. THEORY

Improving a CES starts with access to fuel (considering fuel quality or even diverse fuel options) and considers how to improve cooking devices and cooking equipment for the available fuels. Next steps consider how to adjust user behaviour and cooking practices, improving the ventilation of the cooking space and modifying the kitchen, if needed, to ensure safety for human health.

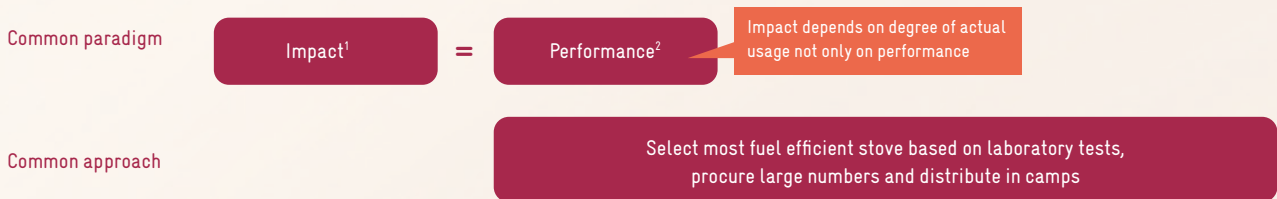


What is the challenge with the common approaches to a CES?

While food is provided to refugees, the fuel to cook that food is often not. Thus, refugees scramble for cooking fuel around the camps, mostly collecting firewood which often leads to depletion of the natural resources, a burden on the mostly female wood collectors, and growing conflicts with the hosting community over resources.

Driven by the necessity to reduce the environmental burden caused by the influx of high numbers of displaced people, the common paradigm follows the logic that the best solution to address the problem is the mass distribution of the most fuel-efficient stove.

Figure 1: Common paradigm & approach.



1 Impact= less deforestation, improved health, improved safety 2 Performance = performance of the technology

The most common approach is to centrally procure stoves, often at head office levels, that promise the highest fuel-savings on paper for distribution in the camps without consulting the users. If the selected stove model doesn't suit users' cooking needs, the stoves are unlikely to be used, and result in graveyards of discarded stoves. While the

performance of the stove technology may have been rated high in laboratory tests, because the rate of usage is low, the impact is low. The intended target is missed completely: it's not the stove itself that achieves the impact, but the actual degree of stove usage. The goals of less deforestation, improved health and safety are missed.

Users may switch stoves during the cooking process, it is important to find out the specific reasons to include the users preferences in different stages of food preparation into the design.





Observing refugees and the host community cooking together on a variety of different cookstoves help to understand their cooking needs.

What is the suggested paradigm shift?

These guidelines suggest a paradigm shift following the logic that only using UCD to create a CES – which considers fuel and stove design together – will lead to the adoption and usage at scale that will contribute to the intended impact to save firewood and improve users' health.

- > Impact is a product of three factors (performance, adoption and scale). If one is low, the product is low.
- > Maximising adoption and scale are as important as maximising performance.
- > An unused stove has ZERO impact.
- > The challenge is finding the sweet spot between performance and adoption together with the users, so that solutions are found that can be scaled.

To **Maximise Impact**, we need

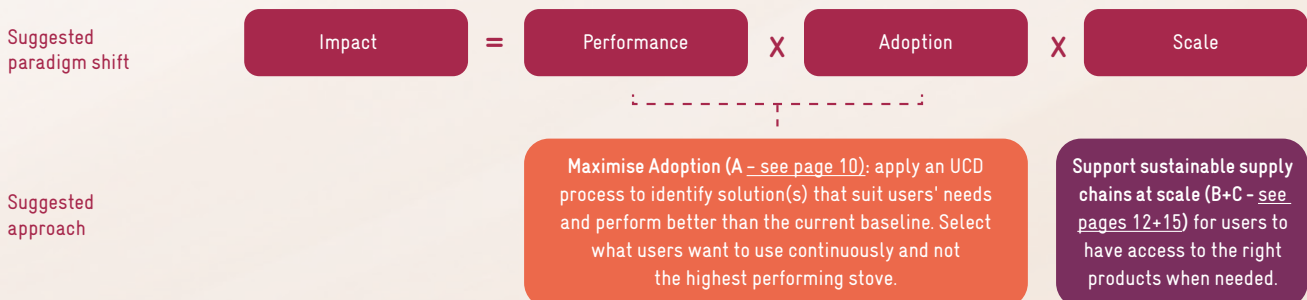
A. Design = a technology/product and/or technique/ method for a CES that offers both

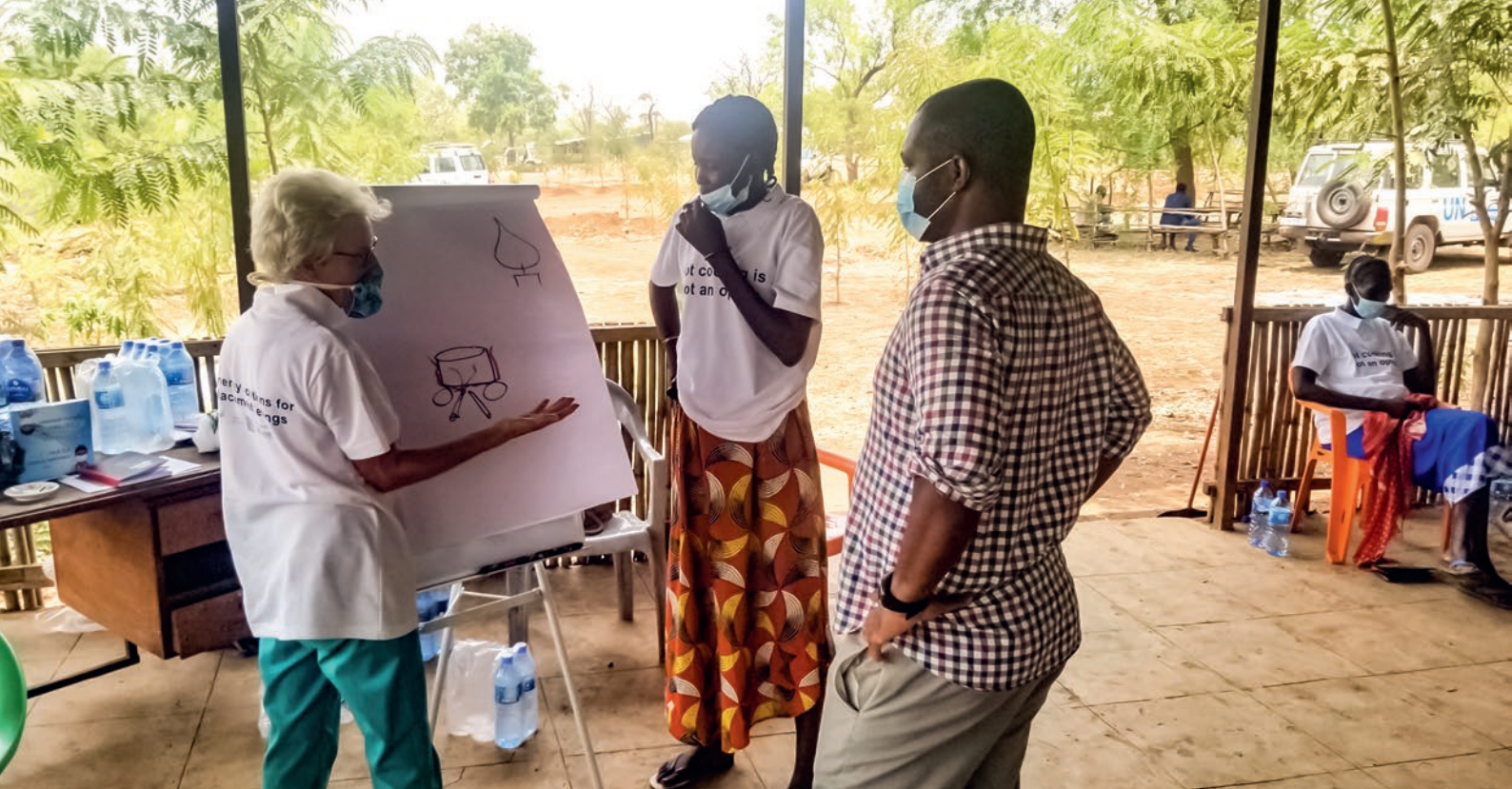
- > Performance (saving fuel compared to current practise) and
- > Adoption (a solution that users want and are likely to use continuously)
- > A UCD process is ideal to identify potential solutions together with the users.

B. Supply through a sustainable **Value Chain** to ensure that users have access to the right product for continuous adoption and the design is implemented by users.

C. Increase (maximise) Scale

Figure 2: Suggested paradigm & approach.





Users learning about efficiency of cooking energy systems and elaborating their preferences is essential for User-Centred Design Process.

A. Design

What is design?

Design is a plan or specification for the construction of an object or system or for the implementation of an activity or process or the result of that plan or specification in the form of a **prototype**, product, or **process**.

What are participatory design approaches including the users?

To ensure that the design is suitable for the users they need to be involved in the process. Participatory Design is an approach that actively involves the future users. When end-users are deeply engaged in design, their aspirations are better incorporated, and needs are more accurately met. This is especially true for people who are facing global poverty challenges and normally don't have a voice in design processes. Participatory design processes can mean different levels and ways of engaging users and different ways of designing and producing the identified product in the end. We mainly distinguish design for people **BY** people, e.g. in co-creation processes or design **WITH** people e.g. **User Centred Design (UCD)**.

Design BY people (Approach | MIT D-Lab)

Design **BY** people can be a co-creation process whereby the future users lead and own the design. This can maximise empowerment of people to find their own solution to their own problems and strengthen self-reliance, including the future production of the design.

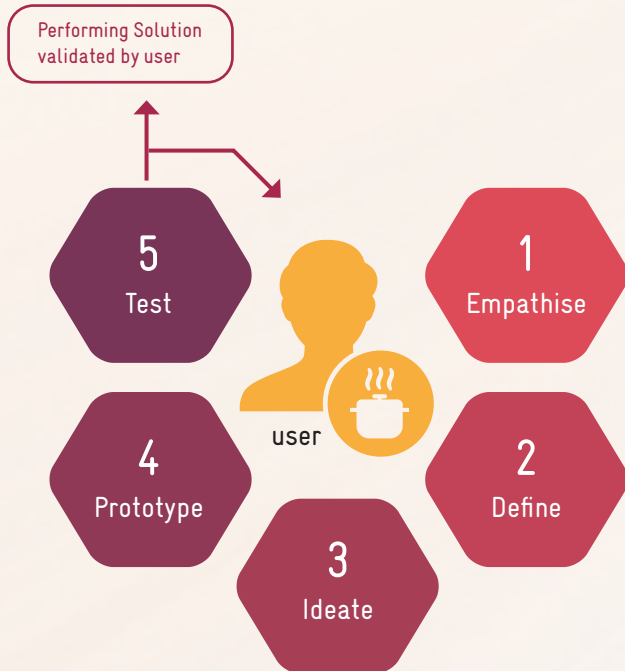
Design WITH people

Design **WITH** People normally involves professionals who design a product with the people engaging the users throughout the process and establishing feedback loops from the very beginning. There can be different names for this approach like **Human- or User-Centred Design (UCD)** or **user-driven development (UDD)**. In general, it is a framework of processes (not restricted to interfaces or technologies) in which **usability** goals, user characteristics, **environment**, tasks and workflow of a **product**, service or process are given extensive attention at each stage of the **design process**. (source: [User-Centred Design - Wikipedia](#)).

Our understanding of UCD is that production is done later by professional producers and not **BY** the people. This can maximise the establishment of efficient value chains and the production of high-quality products that are likely to be adopted by the users.

Our guidelines are based on the design thinking process as a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems, and create innovative solutions to prototype and test. This five-step model — Empathise, Define, Ideate, Prototype, and Test— is most useful to tackle problems that are ill-defined or unknown such as the access to sustainable cooking energy solutions in displacement settings.

Figure 3: Performing solution validated by the user at the end of the UCD process.



At the end of this UCD process, there should be a solution that is tested for performance foremost by the users who also validate that the solution is ready to be produced at scale. Nevertheless, the solution should also be tested by impartial experts for potential finetuning.

If acceptability and usage are low, previous steps of the UCD process must be reiterated until such solution is found. If durability turns out low, ideation might be reiterated before going to prototyping and testing again.

Concrete examples of the five UCD steps are given in Chapter 2 on [Methodology – How to implement a UCD process.](#)

Cooking different meals on different stoves to receive feedback from users.



B. Sustainable Value Chains

Example innovative firewood saving stoves

Value chains and design processes are not linear and cannot be separated. Design is a continuous process which needs to be integrated into the value chain. Products and services should evolve and be re-designed according to the users' (changing) needs. It is a continuous and iterative process which calls for as many loops and iterations as needed to get to a tested and acceptable output.

How does the UCD solution reach the users at scale?

The question is how the solution resulting from a UCD process can reach the users in the displacement settings to create the intended impact through adoption at scale. We use an example of a firewood-saving stove, but the solution can also be a cooking technique, or an alternative fuel, or a combination of innovations.

For sustainable, reliable, and holistic solutions for cooking energy access, the entire value chain from production to usage needs to be functional.

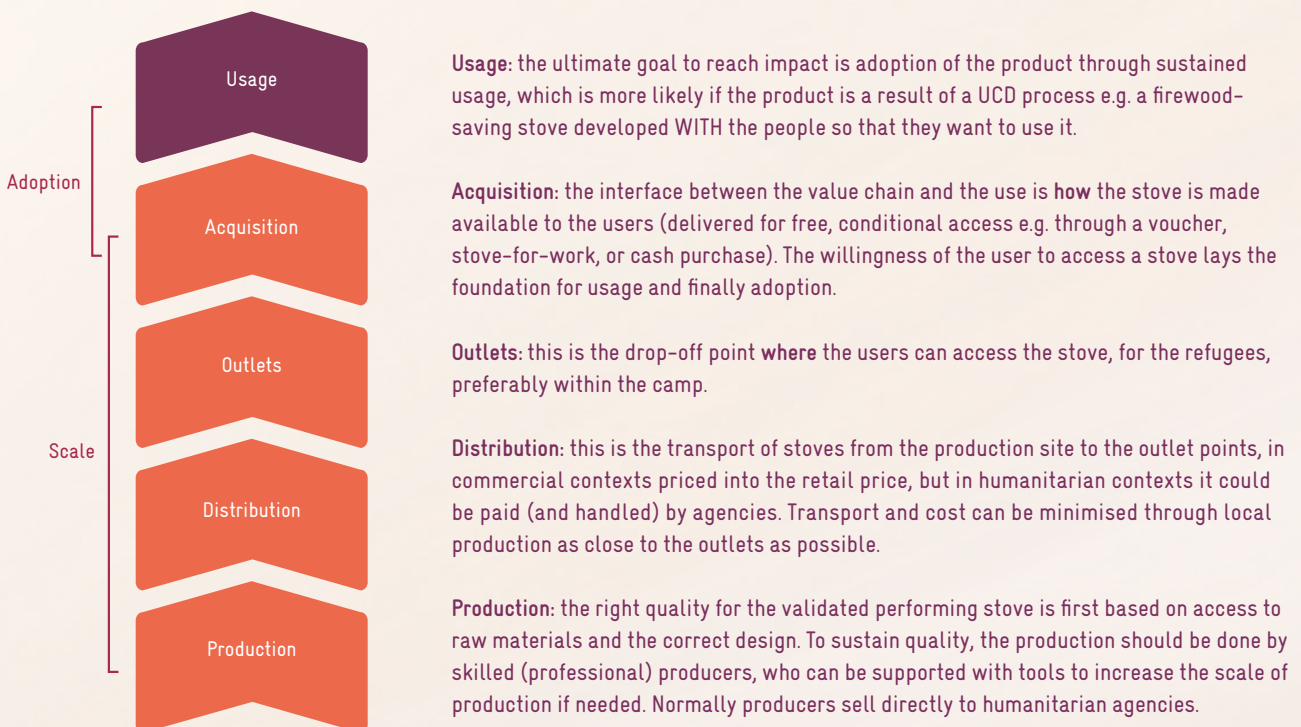
A **value chain** is a set of activities that a sector performs in order to deliver a valuable **product** i.e. **good** and/or **service** to the end customer. (Adopted from [Value chain - Wikipedia](#)).

Preferably a value chain for a firewood-saving cooking energy system would follow a market-based approach answering to the main questions of *'who is involved in turning a raw material into the right product that reaches the users in the right quality and quantity at the right time so that everybody makes a fair profit'*.

Furthermore, value chains for cooking energy systems need to be located as nearby as possible, because a cooking energy system is needed every day.

In a humanitarian context, the commercial aspects need to be adjusted to the reality that refugees are most often at the receiving end with limited purchasing power and/or willingness to pay. At sales points, we talk of *outlets* as drop-off points where the users can *acquire* stoves whether through free distribution, a targeted voucher, or a cash purchase for those with financial means. For *production* and *distribution*, the major difference is that the cost is rarely paid fully by the end-user but by humanitarian agencies. The value chain can be simplified as below:

Figure 4: Value chain cooking energy solutions in displacement settings (example: UCD stove).





Eating and laughing together is an essential part of design, the users of cooking systems will be motivated and open to share their feedback honestly with the designers and facilitators.



According to the users' feedback, the local stove producers have produced clay stove prototypes for further refining.

C. Increase Scale to Maximise Impact

Reminder: **IMPACT = Performance x Adoption x Scale**

Bottlenecks along the value chain, e.g. availability of input materials, production capacity, and transport need to be identified at an early stage in the design process. Constraints can be addressed through e.g. grants for investments, subsidies, result based finance, capacity building, market linkages etc.

Even without the additional challenge of operating in a humanitarian context, engagement in cooking energy system access for households in rural areas of sub-Saharan Africa is rarely a profitable business. Profit margins for producers are low: costs for distribution are high but the willingness to pay for wood-saving technologies is low as access to firewood is often not monetarized and charcoal is mostly produced informally, not considering the actual and environmental costs.

→ Value chains often need financial support to be fully functional, support can be provided through smart humanitarian assistance

Please refer to:

[End-user finance in payment Systems in displacement settings - energypedia](#)

[Harnessing Humanitarian Finance Schemes for Energy Access - energypedia](#)



After the cooking session a participant is serving the jointly prepared food.



2. THEORY IN PRACTICE: METHODOLOGY – HOW TO IMPLEMENT A UCD PROCESS

These guidelines should be taken as some 'steps to guide you' through a process HOW TO implement a UCD process in your own context. They are by no means exhaustive.



<https://www.youtube.com/watch?v=RScrniDRvjE>

A. DESIGN

Ground rules of user-centered design – points to keep in mind

- Combine local and international UCD experts (see box on next page) to span the range of all stakeholders from community level to regional and international organisations
- Iterative/ circular (Design= continuous re-design)
 - Value chain and design are interlinked
 - Producers, designers, users, sellers need to be interlinked
- Holistic/ inclusive approach:
 - consider all stakeholders and the entire eco-system of where and what you design
 - consider everyone, e.g. people who profit from existing value chains or materials
 - consider everything along the cooking energy system value chain, starting with the fuel
- Consider that import of high-performance cooking energy system technology can be as expensive or more expensive as the implementation of UCD, while experience shows that the impact (see IPA formula) of high-performance technology is not always greater.

TIP

Strong and reliable cooperation between **local and international staff and experts** in UCD is best to combine the best of both worlds, complement skill sets, and enhance mutual learning.

Before starting UCD: resource planning

Prior to the implementation of UCD, resource use needs to be planned for each step.

- > Optimal resource planning is important to reduce budget and maximise results for impact.
- > The UCD process can be initiated and conceptualised remotely at office level. At the beginning, a variety of specialist technical UCD expertise is needed to include many aspects of a cooking energy system in the planning. The closer the process gets to the actual users in the camps, the more important local and cultural knowledge becomes.
- > Throughout the UCD process, different skill sets are required at different times and locations. Multi-disciplinary teams to **design with the users** enhance inclusiveness of the UCD process.
- > Access to humanitarian sites is not always given or can be challenging/ expensive. To optimise use of resources and the variety of expertise, it is required to plan what can be done remotely and what needs to be done on-site. Participatory design processes require UCD experts to be teamed up with local UCD experts and staff on-site who are very close to the users. Both are extremely important for the process and their involvement and close cooperation is crucial for the success of User-Centred Design.
- > Complementing skills can maximise efficiency of the process. We recommend a team of international UCD experts and experts with local knowledge input (language, culture, geographical knowledge, reduce travel expenses minimising field time of the international experts etc.) and mutual learning to bring out better results of the UCD process.

Figure 5: Optimise use of available resources for UCD.



How to carry out a UCD process - Steps 1 - 5

Where to do what?

UCD is an iterative process. If you do not get the result that you want, you should go back to the previous steps. Activities can partly be done remotely, but it must be ensured that the user is continuously involved in each step. It needs to be decided in the planning process case by case and based on

the situation what can be done remotely. Preparations for the steps 1 and 2 can be started remotely with information from local experts on the ground, before being carried out on site. However, testing the technology needs to be done under real on-site conditions.

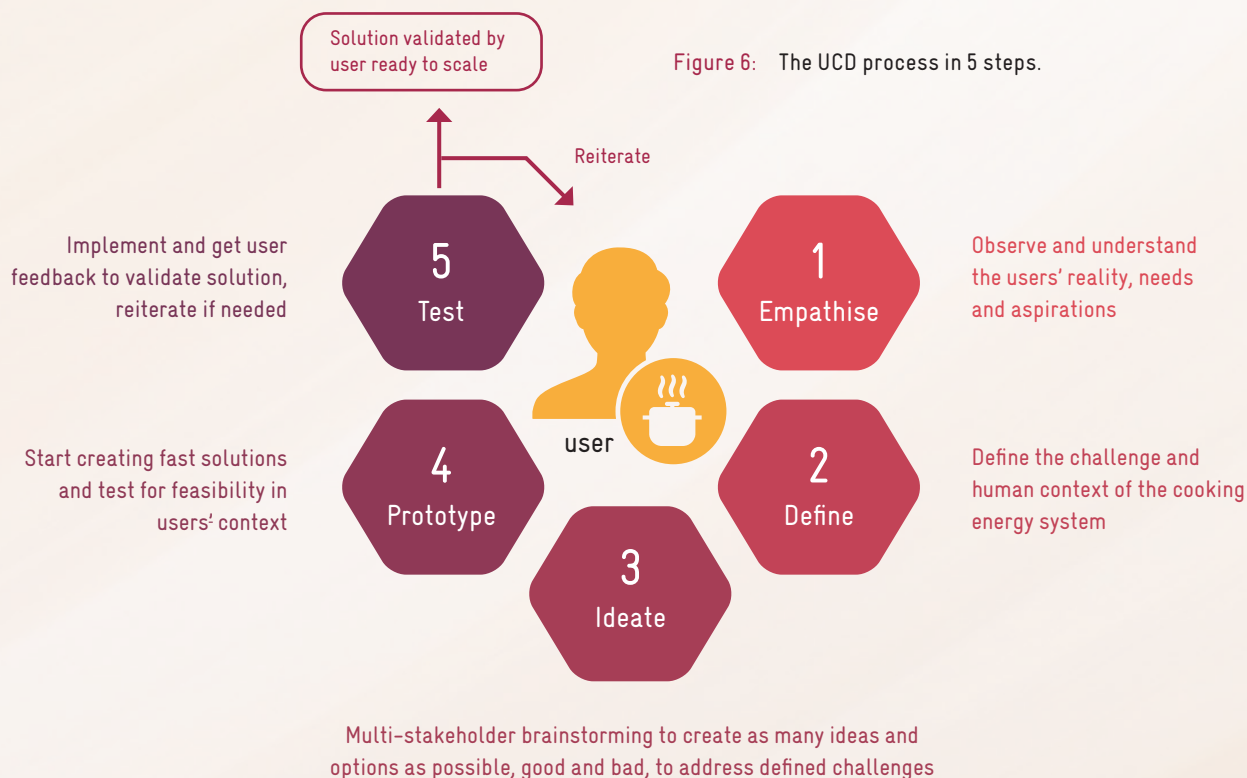


Figure 6: The UCD process in 5 steps.

An **UCD expert** can be an external consultant and/ or staff from your organisation with sufficient time resources to conduct the process. Consider always a team of at least two people with different gender, expertise and local expertise. The team should have the following qualifications:

- Profound knowledge and experience in User-Centred Design processes
- Experience and technical knowledge in developing, prototyping and testing cooking energy solutions
- Good knowledge of the humanitarian and development context
- Good knowledge and understanding of:
 - local value chains, existing businesses in the area, business driving and limiting factors of the area
 - the dominating cooking habits, the socio-economic structure of the community, the culture and decision making of the community

Step 1



<https://youtu.be/RScrniDRvjE?t=224>

Empathise

Identify the preferences and challenges from the viewpoint of the users (refugee and host communities) regarding cooking energy systems in households, as well as the opportunities and challenges of other stakeholders. Information can be gathered in tandem with local experts on the ground and international experts remotely (hereafter called **UCD experts**). Empathy at head-office level is important to get the buy-in in the hierarchy and to get the UCD process started and release budget.

On-site we recommend a two-fold approach:

- 1) let the UCD experts observe habitual cooking in the households without interference and
- 2) complement the information gathered in a Focus Group Event to get 20 habitual cooks together for a cooking demonstration with relevant stakeholders (group should be less than 40 people to remain productive).

Set-Up: What and who do I need to perform the step?	Activities: What do I have to do?
<p>Who?</p> <ul style="list-style-type: none"> • Users (habitual cooks from refugee & host community) • UCD experts • Relevant stakeholders in the existing supply chain of fuels and stoves • Staff from organisations on the ground with a relation to the end-user and connection to the food-energy environment • Energy & environment focal points • Translator <p>What?</p> <ul style="list-style-type: none"> • Venue for cookout in camp • Budget for logistics (transport, food, fuels, stove) 	<ul style="list-style-type: none"> • Get permit for experts & host community to enter camp • Arrange trusted (in many contexts preferably female) translator(s) • Observe day-to-day cooking routines of user households (½ day before lunch: Walk through the camp with the experts) • Inquire about preferred foods (from refugees' origins) • Two full days: Organise Focus Group event including a cookout on-site: <ul style="list-style-type: none"> - Identify venue in a trusted environment for users, with water, shade, space for sitting and cooking outdoors - Invite stakeholders to participate, communicate clear arrangements on conditions (transport, payments, etc.) - Ask users to bring their own pots for the cookout - Organise food ingredients and a variety of fuels, stoves - Give free choice to select ingredients, stoves, and fuels to observe and find out about cooking preferences - Label all dishes with name and place of origin - After the joint meal, let users rank the fuels and stoves according to preferences and reasons for the choice - Discuss experiences and ask for leads for the next step to define the major challenges regarding cooking
<p>Results after these steps: Understand the users' reality and all the steps involved in cooking meals, as well as their challenges, needs and aspirations regarding a cooking energy system.</p>	

Example Gambela: Empathise

To engage with the right people, we had asked UNHCR to select 25 people who are decision makers in their household or practitioners who cook on a daily basis, so we had 21 adult women (5 from the host community and 16 from the camp) as well as 4 men from the camp.

We engaged with these 25 representatives in a central location in the camp for discussions and a cookout in their trusted environment, where they showed us how they cook and which stoves and fuels they preferred. We spent 3 days in the camp:



Day 1: Walk through the camp to observe and prepare the 2-day group event



Day 2: Group discussions with the users (RC&HC) on their cooking energy situation



Day 3: Cooking of the preferred traditional dishes by the users in a trusted environment so they showed us their main preferences and challenges regarding their cooking situation and the choices they make. The joint meal made the cooks proud to showcase their cooking skills and happy to have enjoyed their favourite food which is hard to obtain in the regular camp setting. It created a relaxed positive atmosphere to proceed directly to step 2 to define their major problems and started ideation step 3 of the UCD process.



Top left: Users learning about design and cooking energy on day 2
Others: Users preparing food as part of joint cookout.



Top right: Observation of the baseline situation (that three stone open fire was the most common cooking device) during the walk through the camp on day 1.



Step 2

Define



<https://youtu.be/RScrniDRvjE?t=470>

This step is to define with the users what the major challenge and the human context of the cooking energy system is. It can be done directly at the empathising group event.

Set- Up: What and who do I need to perform the step?	Activities: What do I have to do?
<p>Who?</p> <ul style="list-style-type: none"> • Same group as Step 1 especially the users (habitual cooks from refugee & host community) <p>What?</p> <ul style="list-style-type: none"> • Venue for discussion • Budget for logistics (transport, food) 	<ul style="list-style-type: none"> • Focus Group event (preferably after cookout) on-site • Group discussion facilitated by the UCD experts to identify all the challenges regarding their cooking energy systems including access to fuels, stoves and cooking utensils • Prioritise the challenges to define one or two major problems from the viewpoint of refugees as well as the host community (they might differ) • Elaborate a joint problem statement stating the underlying reasons why the problem is perceived a main priority
<p>Results after these steps: the users and all stakeholders agree on the priorities among the major challenges regarding a cooking energy system and formulate a joint problem statement to define the challenge and the human context of the cooking energy system.</p>	

Example Gambela: Define

All users agreed that the major challenge was the insufficient access to cooking fuels within the camp, which forces refugees to collect firewood outside the camp 3–4 times per week. The viewpoints differed as if looking at the two sides of the same coin:

For all, the major problem was the lack of protection of refugees during firewood collection.

For the host community, it was the competition for the rapidly depleting natural resources.

In the end, the joint problem statement was agreed upon and formulated:

Minimise or suppress collection of fuel wood by refugees around camps.



Top left: Grass and harvest residues were tested as a fuel by the users in different stoves.

Bottom left: After testing the users rated and commented the different cooking systems.

Right: Users preferred the clay stove that created the strongest fire to cook with.

Step 3



<https://youtu.be/RScrniDRvjE?t=779>

Ideate

This step is based on multi-stakeholder brainstorming to create as many ideas and options as possible to address the defined challenges. This is best in a group discussion bringing ideas from users, stakeholders and designers together to realise the concept of the ideal cooking energy system from the viewpoint of the users.

Set- Up: What and who do I need to perform the step?	Activities: What do I have to do?
<p>Who?</p> <ul style="list-style-type: none">• Same group as Step 1 especially the Users(habitual cooks from refugee & host community)• Stove designers and producers <p>What?</p> <ul style="list-style-type: none">• Venue for discussion• Budget for logistics (transport, food)	<ul style="list-style-type: none">• Group discussion facilitated by the UCD experts to brainstorm all possible ideas to increase access to fuels and reduce the need for firewood collection outside camp. The discussion should bring out what field of action the refugees & host community can do by themselves (behaviour change), and where other stakeholders and inputs from outside are needed.<ul style="list-style-type: none">- Develop users' ideal cooking energy system including type of fuel and the resulting type of stove for that fuel- Develop ideas on fuel-saving techniques and technologies to reduce the need for firewood collection- Ideate a 'dream stove' from the features they liked after the cookout on-site in the camp following a checklist for stove properties including materials, shape, height, special features like handles, doors to regulate air etc.• Discuss access to alternative fuel sources e.g. enhancing fuel supply chains from the region
Results after these steps: 1-2 solutions prioritised by users to go into the prototyping stage	

Example Gambela: Ideate

Within the field of action of the refugees, two major interventions were identified with potential to reduce the frequency of firewood collection from currently 3 trips to 1 trip per week:

- 1) **behavioural change:** fuel-saving practices, seasonally substitute firewood with available grass closer to the camp. Expected 20-30% savings of firewood = 1 trip less per week
- 2) **fuel-efficient clay stove:** During the cookout, we observed a clear preference for the clay-stoves for firewood, which was confirmed in the ranking of the stoves we brought. Expected savings with appropriate stove = 30-40% of firewood = 1 trip less per week

Eliminating the last remaining trip outside the camp would not be at the level of the refugees' actions but would require the **engagement of a wider network of stakeholders** like government agencies, UNHCR and partners from GO, NGO and private sector:

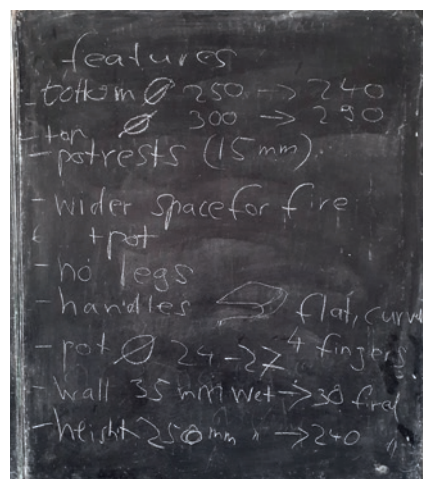
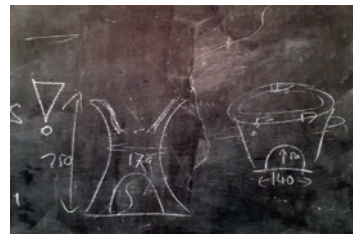
- 3) **Creating access to alternative fuel sources** could completely suppress the need for fuel collection by the refugees.

In the discussions on potential solutions first in the camp with the whole group then a day later in the Gambela administrative centre with some representatives, we went through all potential fuel sources (electricity, LPG, ethanol, biomass etc.) and concluded that biomass fuels from the region would still be the most viable option, provided they come from sustainable sources.

The group agreed that there should be two ways of access:

- through markets for those who can afford it, and
- through transfers for those who can't, in order to leave no one behind.

Top left: Stakeholders in Gambella shared the observation that the shortage of adequate cooking fuel is a major challenge.



Others: Stakeholders discuss ideas to realise concepts and drafts of ideal cooking energy systems from the viewpoint of users.

Step 4



<https://youtu.be/RScrniDRvjE?t=1034>

Prototype

Start creating fast solutions and test them for feasibility in users' context. The solutions should preferably be based on materials and skills that can be found locally or regionally. Economic viability should also be considered from the start, as the best solution that cannot be afforded, either by the refugees or the agencies that would procure the solutions, would end up on the shelf and not in the hands of the users.

Set- Up: What and who do I need to perform the step?	Activities: What do I have to do?
<p>Who?</p> <ul style="list-style-type: none"> • Stove designers and skilled producers of cooking energy systems (if available) • Local producers working the materials for stoves identified in the ideation stage (ceramic) • People with technical and engineering skills (e.g. technical colleges) <p>What?</p> <ul style="list-style-type: none"> • Venue for discussion • Workshop equipped with tools for prototyping • Materials for prototyping • Budget for logistics (transport, food) 	<p>If the preferred solution is an appropriate cookstove:</p> <ul style="list-style-type: none"> • Convene a small group of (local/regional) UCD experts with a mix of technical, mechanical and production skills, representing a range of relevant stakeholders in the cooking energy value chain, such as: <ul style="list-style-type: none"> - practitioners (ideally people that are already producing some type of stove or other potential producers of stoves or parts like tinsmiths, welders etc.) - academia, researchers, vocational trainers etc. - sales agents of stoves, fuels, other commodities - up to 5 users selected by the group of the previous steps - facilitators with experience in developing market-based cooking energy system value chains • Discuss the features of the 'dream stove' from the user group to find out what is feasible in the local circumstances and who potentially can make what at which price where • Agree with the expert group on a couple of sketches for each of the 1-2 stove types (following the stove principles and features that came out of the ideation stage as the 'dream stoves') • Get the appropriate materials and start prototyping on site. This can take a couple of days. If there are no local production skills, then the process to produce a functioning prototype might take longer. • Test the prototype for technical functionality before bringing it to the users. This is easily done with all-metal stoves. In the case of clay stoves that need to dry and be fired before the first use, this is more time-consuming, but the process might be shortened based on experience of the producers or consultants. • If possible, work on the appearance of the prototypes as they should look good to make a first impression
<p>Results after these steps: several technically functioning prototypes produced for each of the solutions prioritised by the users in the ideation step, ready to go out for testing in users' habitual environment (meaning in day-to-day use in their households, for refugees in the camps)</p>	

Example Gambela: Prototype

As we knew already that users preferred stoves made from fired clay, from the start we involved skilled potters who were already producing charcoal stoves in Gambela and invited them to a session at the local vocational training college together with experts in metal production. When going through the features of the 'dream stove' articulated by the users in the ideation step, we realised that it was better to stick purely to clay as a construction material. We continued the prototyping process with the leading potters of the area on their main production site, using their habitual clay mixture.

In 2 days, we produced 14 different prototypes following 2 main design principles that had emerged from the UCD process: a pure firewood stove and a dual-fuel stove for both firewood and charcoal.

We also developed a couple of tools to ease the production process for the potters and ensure standardised dimensions of the final products, as dimensions are critical for stove performance.

We were lucky that the weather conditions were conducive, and the prototypes dried fast enough to fire them the evening before our next scheduled meeting with the users in the camp.



Top left: UCD experts Christa Roth and Egzieryalew Ayele help local stove designers in improving the design and production process.

Top right: Exact measurements of the prototype are crucial for its efficiency.

Centre left: Skilled and experienced potters are needed for the clay stove prototype production.

Centre right: Clay stove prototypes are ready for next steps, such as the firing process.

Bottom: Traditional clay stove firing.



Step 5



<https://youtu.be/RScrniDRvjE?t=1109>

Test/Validate Product

Test the solution with the actual users, both the refugees and host community: a sample size of at least 10-20 stoves is needed to get meaningful feedback. Make sure that every user knows how to use it. If possible, monitor the usage and accompany the correct use in the beginning. Then get user feedback to validate solution. Reiterate if needed. The validation should happen at different levels:

- 1) at the user level in the camps through interviews with users on perceived benefits
- 2) more standardised performance testing by independent facilities to get third-party verification of the performance of the solution and the potential compliance with existing legislation or rules. We suggest a combination of **testing protocols**: The **Controlled Cooking Test (CCT)** to see what users can achieve with the device¹ and a field-based **Water Boiling Test (WBT)** as a more standardised test modified to measure how efficiently a stove uses local fuel to heat water in a local cooking pot to find out the potential performance of the device regarding speed of cooking and fuel consumption (not emissions, as most cooking is done outside and emissions quantification is complicated and costly).



Top: Testing clay stove prototype with users in camp.

Bottom: Ranking of clay stove prototypes after testing.



Set- Up: What and who do I need to perform the step?	Activities: What do I have to do?
<p>Who?</p> <ul style="list-style-type: none"> • Agency or partner staff who is in constant communication with the users in the camp • Stove testing experts, independent consultant • Stove testing experts from a relevant government institution • Regular stove users (in camp) <p>What?</p> <ul style="list-style-type: none"> • Budget for expert's time and logistics for CCT and WBT • Budget for firewood and food (for CCT and WBT) • Venue in or close to camp 	<p>For the test at the user level in the camp:</p> <ul style="list-style-type: none"> • Engage with people in the camp that interact with the users on a regular basis and can collect data on fuel use and regularity of stove usage. • Make a simple recording format where users can record each trip for fuel collection to verify the fuel savings before and after the adoption of the stove • Monitor stove usage and change in fuel use over time <p>For the CCT (Controlled Cooking Test) in camp:</p> <ul style="list-style-type: none"> • Carry out the cooking of a pre-defined meal with different users in the habitual environment under the supervision of a qualified expert with stove testing experience <p>For the WBT (Water Boiling Test):</p> <ul style="list-style-type: none"> • Carry out the testing in a venue as close to camp as possible under the supervision of the relevant government approved stove testers

¹ a Controlled Cooking Test (CCT) is a field test that measures stove performance in comparison to traditional cooking methods when a cook prepares a pre-determined local meal. The CCT is designed to assess stove performance in a controlled setting using local fuels, pots, and practice. It reveals what is possible in households under controlled conditions but not necessarily what is actually achieved by households during daily use.

Example Gambela: Test and validate

We did 3 levels of testing and validation

1) First validation with the users: We invited the stove producers to come along to the group meeting at the camp with the 25 participants of the initial UCD steps. We brought firewood, elephant grass, and different charcoal briquettes for the users to experiment with and light up all 14 stove prototypes with different fuels to observe how they would perform (without cooking anything or measuring the fuel consumption). Afterwards, we asked the group to rank the 14 stoves following their observations and perception of performance. 3 stoves came out as the clear winners: 1 sturdy firewood stove, 2 dual-fuel stoves.

To ease logistics, the representatives of the host community were allowed to pick their preferred stove to take home already. The refugees would choose their preferred model from the 3 top-ranked ones, and we placed an order with the local potters to get them produced.

While waiting for the stoves to be delivered, we asked each user in the camp to record every trip of firewood collection to get an insight on the before and after situation. Most refugees had done 3-4 weekly trips. After they received their chosen stove two weeks later, this reduced to only 1-2 trips.

Second validation with the users on acceptance and performance after one year of usage: All stoves were still in use, which would translate into a very rare 100% adoption. Users were just so convinced about the benefits of the stove that they used them all the time:

- a. They were relieved to reduce their risk as they usually only had to leave the camp once a week to collect fuel.
- b. They loved the portability of the stoves that allowed them to cook out in the open air when the weather allowed, to avoid the exposure to smoke while cooking.
- c. They appreciated that there was hardly any smoke when they had to cook inside the shelters, which would previously fill rapidly with smoke from the open fires, causing their eyes to burn and difficulties for them and their children to breathe.
- d. They also liked that on average cooking with the stoves was faster than on open fires.

2) Validation of system performance with an expert at user level in camp:

We crosschecked users' perception with a Controlled Cooking Test (CCT) by our skilled consultant in the camp with the users. Due to some security issues, this was only possible a year after the initial distribution of the stoves. The CCT consists of cooking a meal whereby the users operate the stove, and the consultant records the data regarding fuel use and time/speed of cooking. The results corroborated the range of fuel savings between 51 and 63%, depending on the stove model and the skills on fuel-saving handling of the stove by the users.

3) Third-party verification of performance regarding fuel consumption: We also engaged the stove testers from the Ministry of Water, Irrigation and Energy to test the stoves officially at least in the region, as no camp permits could be obtained at the time for tests in the users' environment. They performed Water Boiling Tests (WBT) in Gambela with the assistance of the potters, who had in the meantime also adopted the new stoves as their habitual stoves. Based on these results, they issued a certification that the new stove models were in line with government requirements.



All: Clay stove prototype testing and validation.

If the solution hadn't been accepted and found to be performing sufficiently to be in line with the government rules, there would have been a need to refine the design and reiterate previous steps of the UCD process.

It is always advisable to keep monitoring the adoption (continued usage) and the performance of the stoves over time. Any design features should be revised and refined over time based on user feedback to maximise impact.

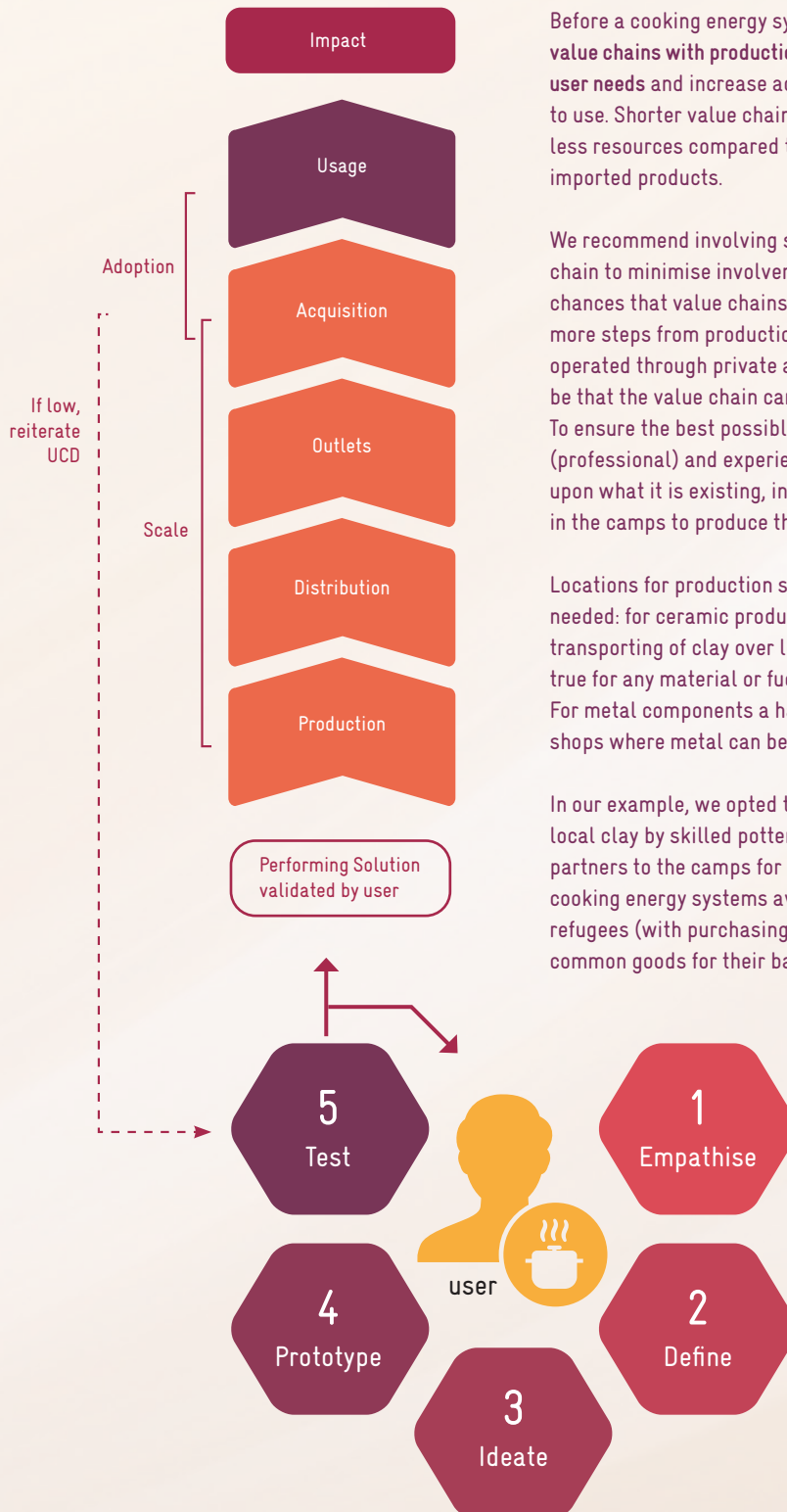
B. SUSTAINABLE VALUE CHAINS

A UCD process without the value chain that ensures that the stoves eventually reach the users will not have any impact. As mentioned earlier, we need to have the entire value chain in mind when we start a UCD process, so that we increase the chances that the value chain can function in the end. The performing solution that is emerging from the UCD process needs to be produced and distributed to outlets where the users can acquire the stoves. Otherwise there will be no usage and no impact.

To establish a functioning supply chain of stoves, it is best to partner with existing stakeholders on any of the steps from production to distribution of the stove models that emerged from the UCD process.

Create Access / link to the Value chain

Figure 7: The User Centred Design Value Chain.



Before a cooking energy system is used it needs to reach the users. Shorter value chains with production closer to the users can react better to changing user needs and increase adoption through a refined product that people want to use. Shorter value chains can be scaled easily on a sustained basis with less resources compared to lengthy procurement processes for costly imported products.

We recommend involving skilled UCD experts in all steps along the value chain to minimise involvement of humanitarian or development agencies. The chances that value chains can be sustained over time normally increases if more steps from production, distribution and operation of the outlets can be operated through private and local business people. The ultimate aim should be that the value chain can eventually function on a market-based approach. To ensure the best possible quality, stoves should be produced by skilled (professional) and experienced experts. It is always recommended to build upon what it is existing, instead of starting completely afresh. Training users in the camps to produce their own stoves bears high risks of failure.

Locations for production should have good access to all raw materials needed: for ceramic production the vicinity to a clay source is important, as transporting of clay over long distances will not be sustainable. The same is true for any material or fuel whereby the mass compared to the value is high. For metal components a hardware store should be reachable as well workshops where metal can be formed, cut, and connected.

In our example, we opted to start with clay stoves that are produced from local clay by skilled potters in Gambela and then transported by UNHCR and partners to the camps for distribution. The aim for the future is to have the cooking energy systems available in a market place near the camp where refugees (with purchasing power) and host community members go to buy common goods for their basic necessities.



Skilled and experienced producers of clay products on the vicinity of the camp were identified before the UCD process. Adding on their skills and product offers is an efficient way to initiate a value chain for cooking energy systems

Example Gambela: Production

We encouraged the skilled potters in Gambela who already professionally produce charcoal stoves for the urban market to simply integrate the new stove models into their portfolio. We also increased their production capacity with simple hand-tools and a large firewood-saving firing kiln. Unfortunately, the new kiln got demolished during road construction works and could not yet be rebuilt.

Both quality and quantity of stove production increased, while costs for firewood decreased. With the scaling of the production, the price per stove went down to ca. 2 USD per stove ex-workshop.

Instead of providing them with financial support, we gave them business and ordered 200 stoves. This helped them to gain more experience and to build up working capital from the stove sales. Then we linked them to other implementation partners who ordered more stoves.

The potters for Gambela have been invited to train others on the production of the new stove models.



Top left: Final steps of clay stove pottering.

Top right: Clay stoves after finished pottering. Clay stoves are ready for firing.

Bottom left: Preparing traditional firing of clay stoves.

Bottom right: Firing of clay stoves.

C. INCREASE SCALE TO MAXIMISE IMPACT

Following the IPA formula, that Impact is a multiplication of Performance and Adoption (actual usage), the value chain needs to be scaled to maximise stove availability at the users' level as a precondition to usage. This sometimes also requires the adaptation of procurement processes to allow bulk purchases of stoves from local producers.

Experience from GIZ Energising Development shows that supporting selected professional producers to increase their output can have a much bigger impact than training a larger number of new or artisanal producers.

Scale can be achieved on two levels: the first is to get more users to use the stoves, the second is to get more implementers to promote the stoves and replicate the UCD experience in other camps.

A word of caution on setting up production in refugee camps or settlements:

Although it sounds like a good idea to establish production by the people in the refugee camps/settlements, we do not recommend that people without required skills and experience are trained to become potters.

It takes time, often more than 2 years, to reach a level of good quality production. Furthermore, the movement of people in refugee camps/ settlements is often high. Experiences in other countries have shown that many new producers get discouraged by the significant fluctuation in newly trained producer groups and can lead to the stop of the entire production. There is also the risk that users get disappointed if the products are not of good quality, which can create a bad image and affect the acceptance of 'improved' stoves in general if they don't perform or last. Sometimes it is more efficient to scale existing professional stove production and make the stoves before they reach the camps.

C.

INCREASE
SCALE
TO MAXIMISE
IMPACT



Top: Firing kiln to fire clay stoves.

Bottom from left to right: Scaling clay stove production with simple tools; Kiln with clay stoves before firing; Kiln loaded with clay stoves during closing and sealing preparation; Transportation of clay stoves - Improvement is needed to reduce breakage rate.





Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

E info@giz.de
I www.giz.de

On behalf of



Federal Ministry
for Economic Cooperation
and Development