ENERGY
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Technical Guide: Clean Cooking

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Cooking is an activity that brings families together and has cultural and social significance around the world. However, the use of solid fuels like wood and coal in traditional stoves typically results in indoor air pollution, causing respiratory illnesses, heart problems and even death. Globally, indoor air pollution causes more than four million premature deaths every year—50% of which are of children under the age of five. Women and children are disproportionately affected due to higher levels of exposure, and since they often spend a significant part of their day collecting the fuel needed to cook a meal.

Despite tremendous efforts, access to clean cooking fuel and technologies has continued to be an issue with severe health, gender, economic, and environmental impacts. Currently, nearly three billion people do not have access to modern cooking services.

The key challenges the sector is facing are:

- **Supply**: The lack of a stable supply of clean, affordable, and culturally acceptable solutions is a major impediment to the adoption of clean cooking by households, particularly in rural areas.
- **Demand**: Lack of knowledge and understanding of the economic, social, and health benefits of exclusively clean cooking serve as a barrier to the adoption of clean household energy.
- **Enabling environment**: A lack of policies focused on clean cooking paired with the allocation of financial resources are critical challenges to facilitating the cross-sectoral collaboration needed to scale up clean cooking.

Technology options

The main problems with traditional cooking methods are related to the supply of the fuel (primarily unsustainable biomass usage), the health risks from smoke and particle release during cooking, and a lack of knowledge and understanding of the pros and cons of the different cooking technologies.

Several clean cooking technologies exist, ranging from making the current cooking process more efficient to replacing it with completely different technologies and fuels.

Improved cookstoves

Cookstoves are commonly called “improved” if they are more efficient, emit fewer emissions or are safer than traditional cookstoves or three-stone-fires. The term usually refers to stoves which burn firewood, charcoal, agriculture residues or dung.

Energy efficiency describes the heat transferred into the pot in relation to the overall energy generated by the stove within a defined task. A higher efficiency can be achieved by:

- Better combustion of the fuel by providing an insulated combustion chamber around and above the fire, which leads to a better mixing of gases, flame and air
- Maximising the transfer of heat of combustion from the flame and the hot gases to the cooking pot
- Minimising loss of heat to the surroundings

Several different designs have been developed, with different levels of efficiency. In order to be able to compare different types of improved stoves, the International Organiation for Standardization (ISO) developed the first international standard for laboratory testing of cookstoves, the ISO 19867-1:2018. This standard specifies testing and reporting protocols to measure and evaluate emissions, efficiency,

safety and durability of cookstoves in a lab setting. It is applicable to stoves used for cooking or water heating in households, small enterprises, and institutions.

Biogas

Biogas production for domestic cooking depends on an affordable, appropriate digester at a suitable scale for domestic use. In any digester, the waste is mixed with water to create the right environment for bacteria to decompose the biomass. As this is an anaerobic process, it must happen without the presence of oxygen in an airtight tank. The biogas accumulates at the top of the tank, where it is collected and taken by pipe to the user. The slurry has to be removed regularly from the tank. It can be also used, e.g. as agricultural fertilizer. Based on this principle a number of designs have emerged. A small-scale biogas system for household use will typically consist of the following components:

- Collection space: raw, liquid, slurry, semi-solid and solid animal, human or agricultural waste
- Anaerobic digester
- Slurry storage
- Gas handling: piping, gas pump or blower, gas meter, pressure regulator and condensate drain(s)
- End-use device: cooker, boiler and/or lighting equipment

Challenges with biogas systems for household use are the upfront investment needed for the technology, the correct feeding of the system and regular removal of the slurry.

Particularly in Asian countries like Nepal, large government-backed development programmes have supported the sector. However, although efforts have been made to develop a viable biogas digester construction industry, no all-inclusive industry has emerged.

Prefabricated biogas systems with standardised components have been developed by a number of emerging companies, some of which are piloting the integration of Pay-as-You-Go technologies. BBOXX, for example, is setting up a project in Rwanda where it has teamed up with a local biogas technology provider and applies its solar PV based PAYG technology to offer an affordable package to the end user. Sistema.bio from Mexico has successfully attracted funding to expand its prefabricated biogas technology into Africa and Asia.

LPG

Traditionally Liquefied Petroleum Gas (LPG) is distributed in large heavy gas bottles with upfront payment only. KopaGas in Tanzania is addressing this issue through PAYG kits that it leases to its customers. These kits consist of a 15 kg cylinder, an LPG stove, and a proprietary smart meter that allows for prepayment of small quantities of gas. The meter collects fuel consumption and payment data, and once the credit balance is depleted, the meter locks automatically and can only be unlocked by topping up via mobile money.

Ethanol

Another emerging fuel benefiting from companies taking a “tool and fuel” approach is ethanol. There are a number of players procuring and distributing bottled ethanol (in liquid or gel form) who continue to show promise, including Green Energy Biofuels in Nigeria, Novogaz in Haiti, and Consumers Choice in Kenya and Tanzania.

Koko Networks is currently piloting innovative solutions to bottlenecks in the supply chain of ethanol. Via "ATMs", customers are able to refill their stove canister with ethanol using mobile money. Currently active in Kenya, Koko intends to spread to other countries in the region as well.

Solar cookers

Solar cookers are an inexpensive way of using the sun to cook.

Solar box cookers typically cook food at temperatures between 90°C (194°F) and 200°C (392°F). They can often accommodate multiple pots, and usually take between one and three hours to cook various foods. The sides and bottom are insulated to retain cooking heat.

Parabolic solar cookers offer another approach to solar cooking by being able to reach higher temperatures and perform more like a traditional stovetop. As such, they require more attention while cooking to avoid burning the food, and must be turned periodically to follow the sun depending on cooking time.

The uptake in households to replace the use of wood and wood-derived products for cooking has been limited. Main reasons are the fact that using a solar cooker will typically mean a drastic change in the cooking pattern, as a solar cooker works optimally during the middle of the day, which is traditionally not the time for cooking. Furthermore, not all types of food can be prepared using a solar cooker, while the co-benefits of other cooking methods, like heating the house, do not exist.

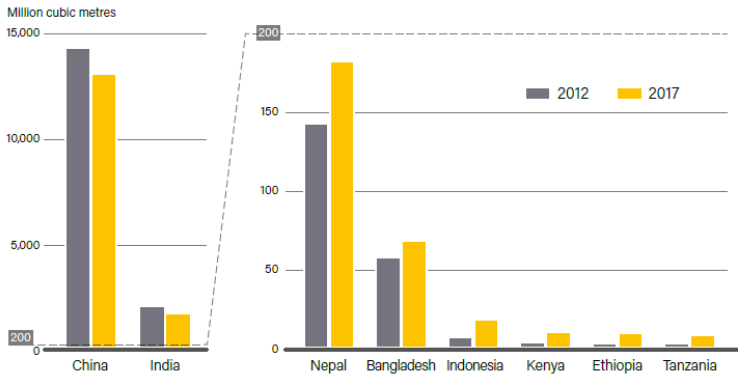

Figure 1 Production of Biogas for Cooking in Selected Countries, 2012 and 2017, Source: REN21 Global Status Report, 2019.

In institutions that traditionally prepare lunches, like schools, prisons and hospitals, as well as in refugee camps, uptake has been relatively successful.

Commercial applications of solar cookers are limited, but an example is solar parabolic ovens for bakeries in Lesotho and Namibia.

Electric cooking

Another approach is to use electricity for cooking. However, as traditional electrical stoves do require quite a lot of electricity, they are not suitable for use with solar PV or localised mini grids. Even for households connected to the electricity network, electric stoves might be too expensive to purchase and use.

In the past, special low wattage electrical cookers have been developed for small mini grids in Nepal. With the current developments of local mini grids and the reduced cost of solar PV, renewed interest has arisen into this technology. Currently, Electrocook and Sunspot are two of the available suppliers. However, a recent Call for Proposals by ENGIE, especially for electric cooking solutions, might bring more players into this market.

Investments in the sector

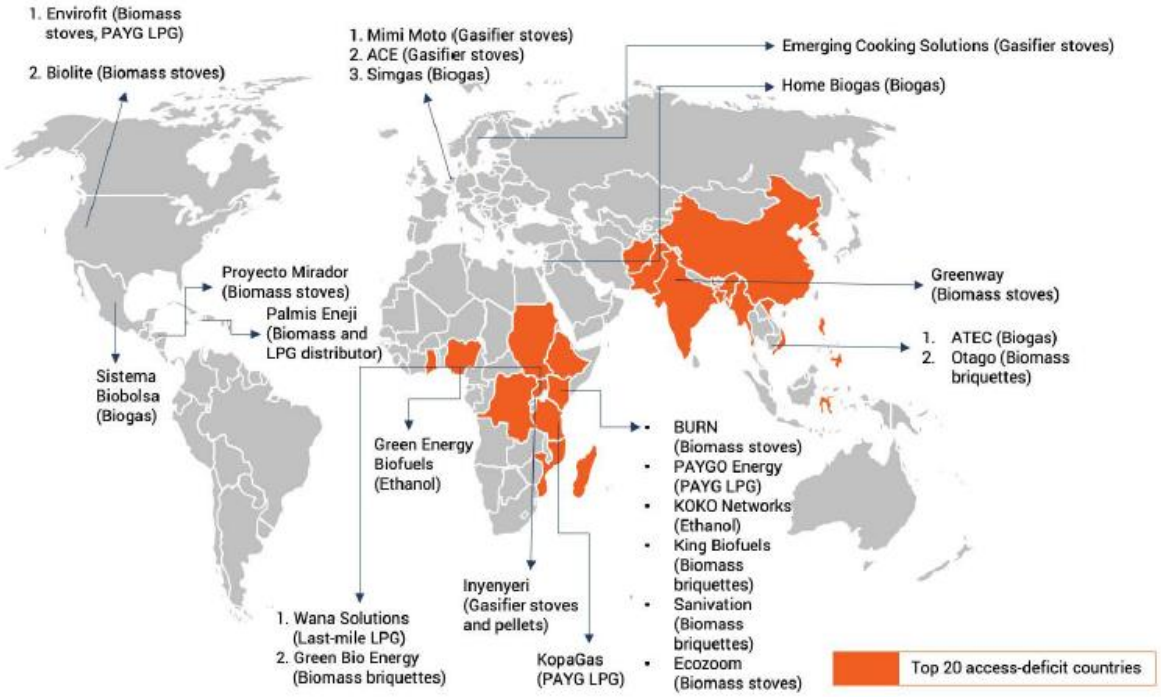

Figure 2 Selected clean cooking companies with largest investments, Source: Clean Cooking Alliance 2019 Clean Cooking Industry Snapshot, 2019.

According to the Clean Cooking Alliance, investment in clean cooking companies in 2017 totalled USD $40 million. This represents a 36% increase since 2016. The total investment level in 2017 was also greater than in any of the previous five years. Nevertheless, it is still insignificant compared to the USD $4 billion required annually for universal access by 2030.

The Alliance is expecting this investment to rapidly scale up once business models have been proven and start to get replicated by competitors.

Particular companies in East Africa (either headquartered there or with substantial operations there) did see increased interest by investors. A combination of enabling policies by East African governments, a well-established charcoal market, and product category awareness and demand for clean cooking solutions as a result of past development programmes helped to set this trend. Dependence on charcoal in urban and peri-urban areas has built demand for biomass cookstoves, and generally shaped consumer dynamics with regards to cooking fuel expenditures.

Several new business models have emerged recently. Particular enterprises selling stoves *and* associated fuels (the so-called “tool and fuel” business models) have attracted increased visibility and investment in the past several years. This category of business models benefits from enhanced consumer data, a stronger customer feedback loop, a regular revenue stream from fuel sales, and the ability to reduce the upfront cost of stoves.

These models are loosely inspired by the computer printer business where relatively cheap, affordable printers are offered while the customer is locked into the cartridge supply by the supplier. By reducing the upfront cost of the stove and recouping that partially through the sales of fuel, customers can be tracked and the risk of un-used stoves is reduced.

Over the past several years, a number of companies have coupled biomass pellets with cleaner, more efficient, fan-driven, gasifier stoves that achieve high quality combustion. Inyenyeri in Rwanda and Emerging Cooking Solutions in Zambia are two examples of companies that have attracted significant attention, as well as public and private sector grants and investment. According to the investment tracking by the Clean Cooking Alliance, these two companies accounted for more than 30% of total tracked 2017 investment globally. Unfortunately, since then, Inyenyeri has not been able to convince investors on the business model and the company was forced to cease operations in early 2020.

Emerging Cooking Solutions and Africa Clean Energy have been piloting Pay-as-You-Go stoves in Zambia and Lesotho respectively. By remotely controlling the built-in electrical fan that is essential for the proper operation of their stoves, they have been able to provide clean cooking solutions on a PAYG basis.

The key challenge such companies face is not primarily related to the stoves, but rather to being able to demonstrate the financial viability of pellet production and distribution. Given various operational challenges to date (including the cost of pelletising technology), they have yet to profitably produce and sell pellets for household cooking use at scale.

Table 1: Active support programmes for clean cooking

Programme	Main activities
Clean Cooking Alliance	The Alliance provides grants for research, capacity building, training, entrepreneur support, in-country alliances and other initiatives that help advance and catalyse the clean cookstoves and fuels sector.
EEP Africa	EEP provides grants, repayable grants and technical assistance for innovative businesses in the renewable energy sector in 15 countries in Southern and East Africa. It targets all renewable energy technologies, but has in the past supported substantial numbers of clean cooking initiatives like, among others, BURN Manufacturing, Emerging Cooking Solutions, Inyenyeri and ACE.
Clean Cooking Fund (CCF)	A World Bank ESMAP fund that will provide financial and technical support, primarily through results-based funding grants, to help countries incentivise the private sector to deliver modern cooking services. It will also establish a global platform for knowledge, innovation, and policy coordination.

Industry associations

The **Clean Cooking Alliance** works with a global network of partners to build an inclusive industry that makes clean cooking accessible to the three billion people who live each day without it. The Alliance's work is built around three core pillars:

- Driving consumer demand for cleaner, more modern stoves and fuels by supporting behaviour change and awareness-raising interventions
- Mobilising investment to build a pipeline of scalable businesses capable of delivering affordable, appropriate, high-quality clean cooking products
- Fostering an enabling environment for industry growth by advocating for effective and predictable policies, providing trusted, relevant data, and serving as the convener and champion of the clean cooking sector

Solar Cookers International improves human and environmental health by supporting the expansion of effective, carbon-free solar cooking in world regions of greatest need. SCI leads through advocacy, research, and strengthening the capacity of the global solar cooking movement.

References and further reading

Clean Cooking Alliance 2019 Clean Cooking Industry Snapshot
https://www.cleancookingalliance.org/resources/566.html

Clean Cooking Alliance Evaluation of Clean Cooking Behavior Change Communication Interventions Summary Report
https://www.cleancookingalliance.org/resources/585.htm

Global status of household biodigesters
https://snv.org/update/snv-report-finds-2018-38000-biodigesters-have-been-installed

GIZ HERA Cooking Energy Compendium
https://energypedia.info/wiki/GIZ_HERA_Cooking_Energy_Compendium

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