Toolkit for the Moving Energy Initiative

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A Review of Cooking Systems for Humanitarian Settings

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Preface

The Moving Energy Initiative (MEI) is a collaboration between GVEP International, Chatham House, Practical Action Consulting, the Norwegian Refugee Council (NRC) and the Office of the United Nations High Commissioner for Refugees (UNHCR). The initiative is supported by the UK Department for International Development (DFID).

The MEI seeks to meet the energy needs of forcibly displaced people in a manner that reduces costs; is safe, healthy and respectful; benefits host countries and communities; and, where possible, creates opportunities for income generation and knowledge transfer to tackle energy poverty and sustainability.

This paper is one of a series of 'toolkits' developed by the MEI partners. It has been written by Practical Action Consulting, with copy-editing and production support from Chatham House, to offer guidance on the design and implementation of improved cooking systems in displacement situations. It is aimed at decision-makers at the policy level who identify priority needs and develop humanitarian budgets, and should be read in conjunction with other publications in the MEI series: *Private-Sector Engagement: The Key to Efficient, Effective Energy Access for Refugees* (GVEP International); and the main report from the first phase of the project, *Heat, Light and Power for Refugees: Saving Lives, Reducing Costs* (Chatham House).

Although displaced people may find themselves in many types of camp or settlement, this toolkit focuses on the refugee camp setting in developing countries. This is where the issue of cooking recurs as a prominent environmental and social concern.

Lastly a word on definitions: a 'cooking system' refers to more than just the cooking appliance, and includes both the stove and the energy it uses. Meanwhile, 'improved' denotes positive changes in the efficiency, emissions, safety, durability, user acceptance, cost, fuel sustainability or other beneficial attributes that a new cooking system can offer. An 'improved cooking system' may use any type of fuel and may include options that meet internationally agreed standards for emissions and safety, as well as options that offer measurable benefits relative to traditional forms of cooking but do not necessarily meet internationally defined benchmarks.

Summary

If cooking provision is neglected in humanitarian operations, the default option is often unsustainably sourced solid fuels burned in inefficient and unhealthy ways on outdated appliances or open fires, with negative impacts on the health, security, finances and overall well-being of displaced populations. To avoid such detrimental outcomes, access to clean, efficient cooking systems should be seen as a basic humanitarian necessity that helps humanitarian agencies deliver more effectively against their duty of care.

Clean, modern cooking solutions are available internationally, and global cookstove standards are being developed based on efficiency and emissions, alongside more sophisticated standards for 'modern energy access' that also take convenience, cost and fuel availability into account. These allow diverse cooking options to be benchmarked and compared. Any successful improved cooking programme also considers cultural and operational aspects of stove design alongside operating costs, financing options and promotional approaches.

Many of the challenges to improving cooking in displacement situations are similar to those encountered in stable communities, and it is important to transfer best practice, building particularly on experiences drawn from the private sector that can promote self-reliance and reduce long-term aid dependency.

Meanwhile, energy provision in the humanitarian context is complicated by some unique features, such as controls on movement, employment and resource use by displaced people, a governance dichotomy between displaced people and hosts, and a dependency culture that inhibits self-reliance and constrains market-based solutions.

Such differences require new approaches that may, in part, need additional funds: the annual cost to displaced people or the agencies that support them of securing advanced, cleaner-burning cooking systems may be $20–30 per person for solid-fuel appliances, and as much as $120 for liquid-fuel or gas solutions. New approaches need more than just money, however. They also require the integration of displaced people and humanitarian support in national economies and development processes, so minimizing isolation and dependency. Treating displaced people as a discrete and helpless population leads to a lack of integration in national energy economies; missed opportunities to share skills, expertise and labour; and indefinite dependence on public funds. The preferable alternative, given that most displacement situations last for decades, is to incorporate displaced people in regional economies and energy markets, to build upon and extend existing clean cooking initiatives to cover settlements where displaced people live, to capitalize on their skills and labour to stimulate local economic activity, and to promote improved cooking systems among displaced people and hosts with equal commitment.

1. Introduction

There are approximately 2.9 billion people around the world who cook and heat their homes with solid fuels.[1] Of this group, who predominantly use open fires and traditional stoves, 96 per cent live in sub-Saharan Africa and Asia.[2] These cooking and heating methods are not only inefficient, they are also responsible for high levels of household air pollution (HAP). Indeed, the noxious pollutants which are produced – such as carbon monoxide – are responsible for a range of health-damaging impacts. Unsurprisingly, these have a disproportionate effect on women and girls, who spend the most time near cookstoves. The World Heath Organization (WHO) estimates that 4.3 million people die each year from exposure to HAP.[3]

Nearly 14 million people became newly displaced by conflict or persecution in 2014, bringing the total number of forcibly displaced people worldwide to nearly 60 million.[4] Ensuring access to clean cooking solutions using sustainably sourced fuel is rarely a priority when providing for displaced populations, as this imperative is set against the more pressing need to secure adequate food and shelter. Displaced people are generally left to source their own fuels and the means to prepare their food, and usually resort to solid fuels and inefficient, polluting cookstoves that expose them to the health risks associated with HAP. Dependence on self-sourced solid fuel has wider social and environmental impacts for displaced people: they may be exposed to personal security risks in the search for firewood; long fuel collection times may leave less time for education, livelihoods, social and other activities;[5] buying fuel may necessitate the sale or exchange of food rations or other goods; and the arrival of displaced people may lead to the clearing of trees for fuel and shelter,[6] exacerbating tensions with host communities and governments, and placing vulnerable groups at further risk.

While displaced people are occasionally provided with cookstoves or fuel on an organized basis, these interventions are not introduced with any consistency across humanitarian programmes. Moreover, fuel provision invariably falls short of actual needs. Given the implications of this ad hoc approach to cooking provision for the health, safety and well-being of displaced people and the communities that host them, the provision of clean, efficient cooking solutions should be seen as a basic humanitarian necessity.

Drawing on the wider experiences of the cookstoves sector in developing countries, this paper outlines lessons learned, and potential challenges and issues to consider when designing clean, modern cooking programmes in situations of mass displacement.

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[1] Solid fuels are defined here as biomass in processed and unprocessed form (wood, charcoal, agricultural and forest residues, dung, pellets and briquettes), as well as coal and lignite.
[2] International Energy Agency and World Bank (2015), *Sustainable Energy for All—Progress Toward Sustainable Energy 2015*, trackingenergy4all.worldbank.org/~/media/GIAWB/GTF/Documents/GTF-2015-Key-Findings.pdf.
[3] World Health Organization (WHO), 'Household (Indoor) Air Pollution', www.who.int/indoorair/en/.
[4] UNHCR (2014), *UNHCR Global Trends, Forced Displacement in 2014*, Geneva: UNHCR, http://unhcr.org/556725e69.html.
[5] Gunning, R. (2014), *The Current State of Sustainable Energy Provision for Displaced Populations: An Analysis*, Research Paper, London: Royal Institute of International Affairs, https://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20141201EnergyDisplacedPopulationsGunning.pdf.
[6] van Dorp Duvilla, M. (2009), *Dealing with energy needs in humanitarian crisis response operations*, Institute for Environmental Security and IUCN Netherlands Committee, http://www.envirosecurity.org/fuel/Quick_Scan_FUEL_project.pdf.

The paper first outlines the types of improved cooking systems available and experiences in their promotion (Sections 2 and 3). Section 4 addresses the unique features of the humanitarian setting, and Section 5 outlines potential approaches to situation assessment and the design of a response package. The annexes present background information, including definitions of cookstove performance tiers, lists of major suppliers and key organizations, data on cookstove performance and cost, and suggestions for further reading.

2. Classification of Cookstoves

Before considering the cooking situation in humanitarian settings, it is instructive to provide an overview of cooking systems in general to identify trends, challenges and lessons that may be transferable. The accompanying publication in the MEI toolkit series (*Private-Sector Engagement: The Key to Efficient, Effective Energy Access for Refugees*, by GVEP International), as well as the main report of the project (*Heat, Light and Power for Refugees: Saving Lives, Reducing Costs*, by Chatham House), provides useful supporting material.

Categorization of stoves by fuel type

Cookstoves can be categorized according to the type of fuel they burn. The most widely accepted protocol – that of the UN Food and Agriculture Organization (FAO)[7] – classifies fuels as solid, liquid or gaseous:

- **Solid fuels** include raw biomass (firewood, charcoal, residues and dung), processed biomass (e.g. pellets and briquettes) and some fossil fuels (e.g. coal and lignite).
- **Liquid fuels** include ethanol and other plant-based liquids, oils or gels, as well as fossil fuels in liquid form such as kerosene and liquefied petroleum gas (LPG).
- **Gaseous fuels** include biogas, syngas and natural gas.

This classification avoids subjective labels such as 'traditional' and 'modern', or 'renewable' and 'non-renewable', recognizing that fuel is only one element of a cooking system. The way in which fuel is sourced, prepared and used determines the overall level of renewability, efficiency and emissions. The pros and cons of the main fuel types are summarized in Annex A.

Categorization of stoves by efficiency and emissions

While networks such as the Partnership for Clean Indoor Air, Bioenergy Lists and Household Energy Development Network (HEDON) have been supporting the development of improved cooking technologies for decades, it was the establishment of the Global Alliance for Clean Cookstoves (GACC)[8] in 2010 that brought significant new impetus to the cookstoves sector. Backed by finance, technical capacity and political support, the GACC has an ambitious plan to reach 100 million new households with clean and efficient cooking technologies by 2020.

One of the GACC's priorities has been the development of international standards for cookstoves that are objectively measurable and fuel-neutral. A set of performance tiers was endorsed in 2012 through an International Workshop Agreement (IWA) facilitated by the GACC that rates devices against four indicators (efficiency, indoor emissions, total emissions and safety), each along five tiers. The draft indicators and the tier boundaries are summarized in Annex B, subject to ongoing review and eventual development of an ISO standard.

[7] Food and Agriculture Organization of the United Nations (2004), 'Unified Bioenergy Terminology', Wood Energy Programme, FAO Forest Department, Rome, ftp://ftp.fao.org/docrep/fao/007/j4504e/j4504e00.pdf.
[8] www.cleancookstoves.org.

Categorization of stoves taking fuel into account

The IWA performance tiers are a step towards objectively defining the meaning of ‘improved cookstove’ (ICS), by setting measurable standards for efficiency, emissions and safety. From the user’s point of view, access to fuel is also an important consideration. This recognition has prompted a shift in the sector beyond the performance of the technology towards the delivery of integrated cooking systems that take into account both the stove and its fuel.

Practical Action has proposed the following minimum levels of energy delivery to achieve modern household cooking and water heating:[9]

- **Access to fuel:** 1 kg of firewood or 0.3 kg of charcoal or 0.04 kg of LPG or 0.2 litres of kerosene or biofuel per person per day, taking less than 30 minutes per household per day to obtain.
- **Cooking efficiency:** Solid-fuel stoves reducing fuel use by ≥40 per cent compared with traditional ‘three-stone fires’.
- **Cooking emissions:** Annual mean concentrations of $PM_{2.5}$ at <10 micrograms (μg) per cubic metre (m^3), with an interim goal of 35 $\mu g/m^3$.[10]

The World Bank’s Energy Sector Management Assistance Program (ESMAP) has gone further in the Global Tracking Framework (GTF) for cooking solutions, by rating access on a scale of zero to five against seven factors (see Table 1). The affordability and convenience of the cooking device help define a ‘modern’ cooking solution under the GTF system, alongside efficiency and emissions.

Table 1: GTF matrix for access to modern cooking solutions

Indicators	Units	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
1. Indoor air quality	$PM_{2.5}$ ($\mu g/m^3$)		To be specified by competent agency (e.g. WHO) based on health risks			<35	<10
	CO (mg/m^3)					<7	<7
2. Efficiency	IWA tiers		Tier 1	Tier 2	Tier 3	Tier 4	
3. Convenience	Stove preparation time (minutes/meal)			<7	<3	<1.5	<0.5
	Fuel acquisition and preparation time (hours/week)			<15	<10	<5	<2
4. Safety	IWA safety tiers			Tier 2	Tier 3	Tier 4	
	or past accidents (burns and unintended fires)					No accidents over past year requiring professional medical attention	
5. Affordability	Levelized cost of stove and fuel					<5% of household income	
6. Quality of primary fuel	Variations in heat rate that affect ease of cooking					No major effect	
7. Availability of primary fuel						Readily available ≥80% of year	Readily available throughout year

Source: ESMAP, ‘Beyond connections: Energy access redefined’, World Bank, Washington, DC.

[9] Practical Action Consulting (2014), *Poor people’s energy outlook 2014,* http://policy.practicalaction.org/policy-themes/energy/poor-peoples-energy-outlook/poor-peoples-energy-outlook-2014.
[10] $PM_{2.5}$ refers to particulate matter ≤2.5 microns in diameter.

Cooking systems can also be assessed according to social, economic and environmental impact, taking into account such additional factors as gender, time use, perceptions of users, employment creation, entrepreneurship opportunities and effects on natural resources.

Debate continues on the best way to classify stoves and the validity of the IWA and GTF tiers, with some questions as to whether the lower emissions of particulate matter and carbon monoxide observed in laboratory test conditions can really guarantee clean cooking outcomes and, in turn, deliver positive health impacts in real-world situations. A recent WHO guideline for indoor air quality concludes that significant health benefits have yet to be delivered by solid-fuel stoves, and that progress can only be achieved reliably by a switch to cleaner energy sources such as biogas, ethanol, LPG, natural gas and electricity.[11]

A recent report for the MEI series by Chatham House presents energy scenarios for the humanitarian situation in which the cooking-related emissions from refugee camp and non-camp settings under different energy mixes are compared, on a continuum from total firewood dependency to the dedicated use of LPG.[12] While noting that the emissions are much reduced in the non-firewood scenarios, a large-scale switch away from firewood and charcoal is deemed unlikely to materialize for much of the developing world within the foreseeable future. Health outcomes are also only one among many considerations in the promotion of improved cooking systems. Therefore, despite the known limitations of existing ICS's in reducing emissions from solid fuels, intermediate steps are still very much required to improve the performance of solid-fuel cooking systems, while alternatives are also explored.

Summary

International cookstove standards are under development, based on laboratory tests for efficiency and emissions.

Broader standards for 'modern energy access' go beyond the cooking technology to consider convenience, cost and fuel availability. Social, economic and environmental factors bring further sophistication to the definition of improved cooking systems.

While solid fuels may never be as clean-burning as liquid and gaseous alternatives, they will dominate household cooking for the foreseeable future. This makes the development of better-performing solid-fuel systems an important intermediate priority.

[11] WHO (2014), *WHO Guidelines for Indoor Air Quality: household fuel combustion*, http://apps.who.int/iris/bitstream/10665/141496/1/9789241548885_eng.pdf?ua=1.
[12] Lahn, G. and Grafham, O. (2015), *Heat, Light and Power for Refugees: Saving Lives, Reducing Costs*, Chatham House Report for the Moving Energy Initiative, London: Royal Institute of International Affairs, https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/20151117HeatLightPowerRefugeesMEILahnGrafham.pdf.

3. Review of Available Cooking Systems

Categorization of available cookstoves

Improved cookstoves were historically manufactured in the informal sector from low-cost materials using basic tools. As global interest in modern cooking solutions has risen, and with it the availability of funding and expertise, factory-made devices of significantly higher quality and performance have also come on to the market. By 2014 at least 50 cookstove manufacturers targeting developing-country markets were achieving annual sales of over 20,000 units (of which 10 firms were selling over 100,000 units).[13] A selection of leading suppliers and their products are described in Annex C.

The ESMAP typology was applied to define five categories of cooking technology – see Table 2.

Table 2: Cookstove classification

	Legacy and basic ICS	Intermediate ICS	Advanced ICS	Modern fuel stoves	Renewable-fuel stoves**
Key features	Small functional improvements in efficiency over baseline technologies; typically artisan-manufactured	Rocket* designs with significantly improved efficiency; some manufactured with high-end materials	Fan jet or natural draft gasifiers with high combustion efficiency; may require pellets or briquettes	Use fossil fuels or electricity; high fuel efficiency; very low CO and PM emissions	Energy from renewable sources
Typical technologies/ fuels	• Legacy biomass and coal chimney • Basic efficiency charcoal stove • Basic efficiency woodstove	• Portable rocket stove • Fixed rocket chimney • Highly improved charcoal stoves	• Natural draft gasifiers (top-lit up-draught or side-loading). • Fan gasifier/ fan jet • Char stoves	• LPG and dimethyl ether (DME) • Electric/ induction • Natural gas	• Biogas • Ethanol • Methanol • Solar ovens • High-efficiency biomass stoves with managed fuel supply • Renewably sourced electricity

* A rocket stove burns small-diameter logs in a combustion chamber that contains a vertical chimney.
** The term 'renewable' is context-specific; it can apply to solid biomass if the source is sustainably managed.
Source: Definitions based on wording as published in ESMAP and GACC (2015), *The state of the global clean and improved cooking sector: Technical Report 007/15*, World Bank, p. 13.

Based on data from the GACC stove catalogue,[14] HEDON stove database,[15] UNHCR reports, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), USAID, Chatham House and manufacturer websites, 47 cookstoves were reviewed against this typology. The resulting classification is shown in Table 3. Devices known to have been used in refugee operations are indicated in red text.

[13] ESMAP and GACC (2015), *The state of the global clean and improved cooking sector: Technical Report 007/15*, World Bank, https://openknowledge.worldbank.org/bitstream/handle/10986/21878/96499.pdf.
[14] catalog.cleancookstoves.org.
[15] www.hedon.info/Stoves+Database.

Table 3: Classification of sampled cookstoves

Stove type	Household (HH) or Institutional (I)	Brand name	Manufacturer/ supplier			Typical distributors				Fuel								
			Commercial	Artisanal/NGO	Not attributable	Commercial	NGO	Government	Other	Wood	Charcoal	Briquettes	Pellets	Residues	LPG	DME	Natural gas	Electricity
Legacy and basic ICS	HH	Anglo Supra Nova		■					■				■	■				
		ARTI Laxmi		■			■											
		Canamake Ivuguruye		■			■			■	■							
		Ceramic Jiko		■			■			■	■							
		CookMate								■	■							
		Mayon Turbo		■					■					■				
		Obamastove	■			■				■	■	■	■					
		Uhai		■			■			■	■							
		Upesi portable		■			■							■				
Intermediate ICS	HH	Apon chulah	■		■	■				■	■		■	■				
		BioLite HomeStove	■			■								■				
		CH-5200			■				■	■	■							
		Darfur stove V.14	■			■	■											
		Econochar			■				■	■	■							
		Econofire			■				■									
		EzyChar	■			■				■	■							
		EzyStove	■			■												
		G-3300			■				■									
		GNG 2nd Gen.		■				■						■				
		M-5000			■				■									
		PCS-1			■				■	■	■	■	■	■				
		Plancha HM-5000			■				■									
		Prakti Single	■			■				■	■							
		Save80	■			■	■											
		StoveTec GreenFire	■			■				■	■							
	I	EFI-100L			■				■									
		Rocket stove			■		■			■	■	■						
		Super Combined Instnl. Stoves	■			■												
Advanced ICS	HH	ACE 1	■			■						■	■	■				
		Belonio		■					■									
		Jinqilin	■						■			■	■	■				
		Mwoto Quad2	■			■						■	■	■				
		Oorja	■			■							■					
		Philips HD4008	■			■	■					■	■					
		Philips HD4012	■			■	■					■	■					
		Vesto Stove	■						■	■	■			■				

Stove type	Household (HH) or Institutional (I)	Brand name	Manufacturer/ supplier			Typical distributors				Fuel								
			Commercial	Artisanal/NGO	Not attributable	Commercial	NGO	Government	Other	Wood	Charcoal	Briquettes	Pellets	Residues	LPG	DME	Natural gas	Electricity
Modern fuel stoves	HH	Prestige Induction Cooktop	■			■												■
		Pureflame			■			■							■		■	
		Télia n°2	■			■									■			
Renewable-fuel stoves	HH	All Season Solar Cooker	■			■												■
		Bio Moto			■				■						■	■		
		CleanCook	■			■									■			
		Cook up inox	■			■												■
		F2-m	■		■												■	
		Fortune cooker			■				■									■
	I	Biogas rice cooker	■			■											■	
		Generic biogas single stove			■				■								■	

The table indicates the diversity of cookstoves available in each performance category. At least 12 of the models listed have been introduced in refugee situations, primarily in East and Central Africa.

Key parameters to be considered when selecting a cookstove for promotion are the design of the device (including convenience, cultural appropriateness and user acceptance), its cost (in terms of both the stove and its fuel), financing options and potential distribution models. These aspects are considered in the following sections.

Cookstove design considerations

Cooking is a personal experience that lies at the heart of family life; any intervention designed to change the way in which people prepare their food requires significant cultural sensitivity. Some of the design considerations *other than cost and efficiency* that need to be taken into account when developing an improved cookstove are:

- Durability – to withstand heat, pot weight, and wear and tear.
- Stability – to ensure safety and usability, especially for foods that require vigorous stirring.
- Ease of lighting, for convenience and speed.
- Cooking speed, especially where water is routinely boiled for staple dishes (e.g. rice or porridges based on milled cereals or grains).
- Ability to use fuels that are available, affordable and sustainable.
- Portability, where outdoor cooking may be desired in some seasons or weather conditions.
- Radiant heat output, where the stove may be needed for house-warming in cold weather.
- Fit with existing utensils, so that ideally new pots are not required.

- Visual attractiveness and build quality, to make the stove appealing and worth investing in (particularly as market-based approaches take over from the subsidized promotional programmes of the past).
- Price and availability, weighed against products already available.
- Clean-burning performance, to reduce HAP (noting, however, that not all users dislike smoke as it repels insects, waterproofs thatch and ripens some foods).

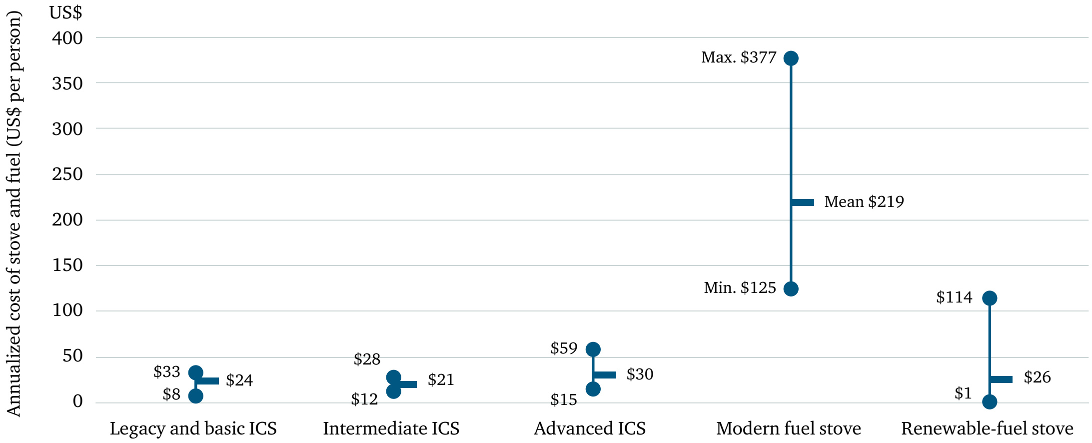
Operational and cultural factors such as these have always played an important role in the adoption of cookstoves. A study in Guatemala found that women stopped using ICS's because they failed to offer the social focus of an open fire.[16] In Zimbabwe, Practical Action's country team report that a stove is considered a woman's asset, and that when she dies it is given to her relatives; this is one reason why fixed stoves are not preferred.

It is clearly important to move beyond the technological aspects of stove performance to provide an integrated cooking solution that consumers find attractive, functional, competitively priced, appropriate to their needs and – most importantly – a measurable improvement on the system they currently use (in order to justify the risk of making a switch). Important to consider in this context is the involvement of users during the design phase of a stove and in any decision on which stoves to offer in a particular context. Different models of stove should ideally be offered to provide freedom of choice.

Cooking system costs

The sampled cookstoves vary widely in price, fuel type, efficiency and lifespan. One way to compare them is to apply the standardized measure of *total annualized cost of cooking for one person*. This takes into account the purchase price of each stove, annualized according to its expected lifespan, added to the cost of fuel for one year's individual cooking. Figure 1 presents the results of this comparison.

Figure 1: Annualized cost of improved cooking systems, by category (stove plus fuel, 2015)



Note: Solar and biogas stoves (under the 'renewable fuel' category) have been excluded as solar is a supplementary option rather than a replacement, while biogas is primarily a communal or institutional solution.
Source: Author's own research. See Annex E for data and methodology.

[16] Bielecki, C. and Wingenbach, G. (2014), 'Rethinking improved cookstove diffusion programs: A case study of social perceptions and cooking choices in rural Guatemala', *Energy Policy,* 66:350–58.

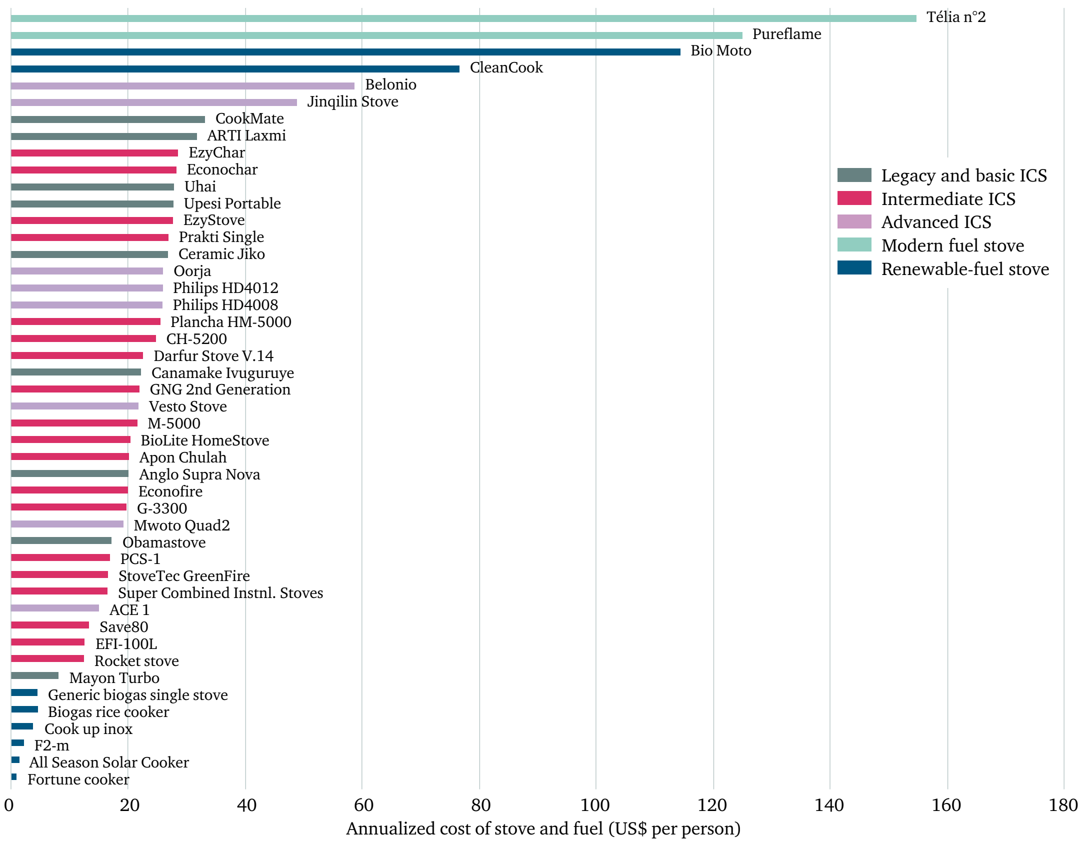
This simplified financial analysis is highly context-dependent, particularly on local variations in stove and fuel pricing; overheads for promotion, distribution and programme oversight; drop-offs in stove use or performance over time that would shorten average lifespan; and the degree to which new stoves are used alongside existing devices (so dual operating costs apply).

With these important provisos, the chart illustrates two important points relevant to the promotion of improved cooking systems. First, the analysis suggests that it would currently cost between approximately $12 and $59 per person per year to buy and operate an intermediate or advanced cookstove for solid fuel (averaging $21 for the former and $30 for the latter). This has budgetary implications if the provision of clean-burning stoves and fuels is to be taken seriously at scale. Second, moving to devices that use fully renewable fuels (such as ethanol) or to truly 'clean and modern' cooking options (using gas or electricity) is likely to cost significantly more than even the most expensive solid-fuel device (averaging $95 for ethanol and $140 for LPG devices, with the electric induction option much costlier). This implies that the highest-grade solutions require a step-change in expenditure.

The analysis includes three institutional stoves in the 'intermediate ICS' category (see Table 3). Their annualized cost of $12–16 per capita is at the lower end of the range (details in Annex E). Most families are nevertheless unwilling to sacrifice individual control over cooking for a mass catering alternative, and this remains an option best suited to institutions such as hospitals and schools.

The annualized operating costs for each of the sampled stoves are presented in Figure 2.

Figure 2: Annualized cost of improved cooking systems, by stove type (stove plus fuel, 2015)



Note: Excludes Prestige Induction Cooktop, with an annualized cost of $377, as its particularly high value would skew the chart and make lower readings difficult to interpret. Source: Author's own research. See Annex E for data and methodology.

Again, while there are outliers at both ends of the scale, the chart suggests that most intermediate or advanced cooking systems have an annualized cost in the $20–30 range, while options for 'modern' and 'renewable' fuels are in a much higher price bracket.

The very cheapest options appear to be solar and biogas systems, but they face some practical limitations: solar is only viable as a supplementary option because it can only cook food during the middle of the day and cannot cook all types of food,[17] while biogas is suitable only for institutional use because domestic application usually requires stall-fed livestock and ample water supply, which are unrealistic in most displacement settings. Both also face significant barriers to adoption because of user resistance.

This is a highly simplified analysis. The actual cost of acquiring particular stoves and fuels will vary by country, region and location. This is also a purely financial analysis. Various economic factors also need to be considered in a comparison of cooking systems. These factors include the loss of natural resources from potential over-harvesting of woodfuel, lost work days and healthcare costs resulting from HAP-related ailments, the impacts of sexual and gender-based violence against women and girls collecting firewood, and house fires started by open flames. Chatham House has attempted to quantify some of these costs in a recent report for the MEI.[18]

Cookstove financing

The public sector has long financed the cookstoves sector in many countries, to generate social impact and kick-start private enterprise. In the past decade there has also been an increase in commercial and social-impact financing. A private-sector approach ultimately promises to build more durable capacity that can sustain permanent cookstove supply chains.

Where donor or government subsidies persist (e.g. in Nepal), market-led initiatives may struggle because they can be undermined by cut-price products and services. Rather than using public funds for a direct subsidy to consumers, such funding is generally best directed towards supporting functions such as product development, market research, sales promotion and customer tracking and analysis, or towards providing risk capital for credit schemes. In Africa, many savings and credit groups exist and can offer consumer financing for household appliances such as cookstoves. Other credit options have been developed through commercial banks, micro-finance institutions and pay-as-you go (PAYG) schemes via mobile money systems. For PAYG, a 10–30 per cent down-payment secures the stove while the customer continues to pay instalments towards full ownership. Wana Energy Solutions in Uganda uses a six- to 12-month PAYG model for LPG stoves.[19]

Carbon funds are also widely used to support improved cooking technologies, often to subsidize cookstoves at the point of sale. This can present competition to producers lacking a carbon finance stream (e.g. in Rwanda, where some carbon-financed stoves are given away for free). Of the estimated 8.2 million stove sales tracked by the GACC in 2012, half involved an element of carbon financing. Carbon prices for cookstove programmes achieved the highest average price by category in 2014 ($6.4 per tonne of CO_2 equivalent), with new voluntary methodologies being created specifically for the cookstove sector.[20]

[17] A recent study by Practical Action Consulting in the Goudoubo camp in Burkina Faso found that a solar-tube cooking system is only used as a secondary stove.
[18] Lahn and Grafham (2015), *Heat, Light and Power for Refugees*.
[19] www.waesol.com.
[20] Hamrick, K. et al. (2015), *Ahead of the curve: State of the Voluntary Carbon Markets 2015*, Forest Trends Ecosystems Marketplace, http://forest-trends.org/releases/uploads/SOVCM2015_FullReport.pdf.

Cookstove distribution models

Cookstoves can be disseminated in many different ways. SNV, a Dutch non-profit development organization, researched cookstove marketing in Asia, Africa and Latin America, and identified three distinct models employed by promoters.[21] These are summarized in Table 4.

Table 4: Cookstove distribution models

Model	Description	Advantages	Challenges
Village-level entrepreneur (VLE)	Promoters work through micro-distributors at local level, taking advantage of their knowledge and networks to sell goods door-to-door and provide customers with advice and demonstration. The *Franchise Dealer Model* is a variant in which a chain of franchisees distribute standardized products. Living Goods is an example of an organization employing this model.[a]	• Low investment costs • Entrepreneurs have direct knowledge of customers • Scalability	• Difficult when product is new or unknown • Hard to reach scale at which VLEs find stove sales sufficiently attractive to fully commit • High financial risk • Limited control over messaging by manufacturer or master distributor • Limited scope for branding or product diversification • Difficult to set up consumer financing and after-sales service
Piggybacking	Suppliers try to overcome the costs of 'last mile' distribution by teaming up with other delivery partners, such as wholesalers, supermarkets or hardware stores.	• Low investment costs • No additional infrastructure required • Shorter time to establish markets • Network builds on prior consumer trust • Scope for consumer finance	• Network actors need to be committed and engaged to the new product(s) • Potentially limited market can rapidly become saturated (depending on market reach of the partner) • Limited control and oversight
Proprietary sales network	An entirely new distribution channel is set up using the promoter's own distributors and sales team. Elements of the VLE or piggyback models may also be applied.	• Full control and oversight • Avoids middlemen and their mark-ups • Enhanced opportunities for branding • Facilitates consumer financing and after-sales service	• Costly upfront, with high financial risk • Difficult to reach customers in remote areas, given costs

[a] www.livinggoods.org/what-we-do/micro-franchise-business-model.
Source: SNV, 2015.

The study found that the natural conservatism of resource-poor families in developing countries, especially in rural areas, means that a number of mutually reinforcing approaches may be required to make sales of a new cooking device. Awareness creation through mass media can be effective in reaching large audiences quickly, but community-specific efforts (including one-on-one marketing) are still often needed to fully convince households to take up an unfamiliar technology. Marketing messages are usefully reinforced by respected figures within the community such as health workers

[21] SNV (2015), *Mapping Successful Cookstove Distribution Models: Eight Success Factors to Reach the Last Mile,* https://beamexchange.org/uploads/filer_public/e5/0d/e50d9a26-f413-4878-9160-1c48dcb1de4e/mappingcookstoves_distribution.pdf.

or teachers. Men must be included in sensitization efforts as they are invariably the decision-makers for new household purchases. Successful marketing focuses on immediate personal benefits such as saved money or time, rather than less tangible outcomes such as environmental protection or health improvement.

These important lessons are transferable to the humanitarian setting, where the GVEP International 'toolkit' paper on *Private-Sector Engagement* for the MEI highlights the role that commercial actors could play in alleviating challenges associated with scaling or optimizing energy access, given their skills in providing energy products and services that are demand-driven and market-tested.

Summary

A successful cookstove programme must consider design aspects, costs of purchase and operation, financing options and promotional approaches.

The average annualized cost of a stove plus fuel varies from $21 per person for intermediate devices to $30 for advanced devices, $95 for ethanol stoves, $140 for gas stoves and $219 for electric. Intermediate and advanced options for solid fuels therefore often represent the most realistic option. Exact figures are highly context-specific.

Private-sector investment builds durable capacity to sustain cookstove supply chains. Public funds should be directed towards supporting functions and should avoid subsidizing specific products.

Successful marketing focuses on personal benefits such as saved money or time, rather than on environmental protection or health improvement.

Cookstove promotion in rural or poor communities requires personal visits and one-on-one marketing, in addition to awareness-raising via mass media.

4. Clean Cooking in the Humanitarian Setting

Experiences with cooking improvement in humanitarian settings

The increasing sophistication and quality of cookstove programmes in the global context has been mirrored by developments in the humanitarian sector.

Early interventions to promote improved cooking in displacement situations supported refugees to build their own basic cookstoves using local materials. In Uganda during the 1990s, for example, refugees from Rwanda were encouraged to build household mud-stoves, and competitions were run to reward innovative designs. Similar approaches with Rohingya refugees in Bangladesh resulted in the construction of a stove with its fuel entrance underground and the pot resting at floor level.

Attempts were also made to promote alternative fuels, with mixed results. During the mid-1990s, for example, a grass-burning stove was promoted in East Africa, but was not adopted by refugees as it demanded too much labour, was inconvenient to operate and required a significant change in cooking habits.[22] The experience highlighted the importance of aligning stove designs with refugees' cooking traditions and culture. Recent field research has confirmed that 'fuel efficiency is not the sole determinant of user preferences. Ease of use, safety, level of smoke, and taste of food are also key factors in the choice, assuming all models are equally available and affordable'.[23]

From the 2000s onwards, cookstove designs have become more elaborate, bringing industrial manufacturers and social enterprises into partnership with humanitarian actors. The variety of solid-fuel stoves introduced to the humanitarian sector has grown enormously as a result. For example:

- In Kenya, GIZ managed a 20-year energy and environment programme that included the distribution of *maendeleo* portable firewood stoves to 68 per cent of refugee households, made at production units within the camps.[24] This was in addition to a monthly ration of sustainably sourced firewood, though budget constraints meant that this met only 10–15 per cent of refugees' needs.[25]
- In Haiti, the International Lifeline Fund (ILF) distributed 13,000 stoves to people displaced by the 2010 earthquake and went on to produce stoves for commercial sale. About 12,000 charcoal-burning Recho PlopPlop+ stoves were sold via distributors and micro-vendors.[26]
- The Lawrence Berkeley National Laboratory has been working in Darfur since 2005 and has designed improved stoves tailored to the local climate and cooking practices.[27] The Berkeley-Darfur stove is distributed by Potential Energy.

[22] Owen, M. et al. (2002), *Cooking Options in Refugee Situations: A Handbook of Experiences in Energy Conservation and Alternative Fuels,* UNHCR, http://www.unhcr.org/406c368f2.pdf.
[23] USAID and Berkeley Air Monitoring Group (2010), *Evaluation of manufactured wood-burning stoves in Dadaab Refugee Camps, Kenya,* USAID, http://www.ehproject.org/PDF/ehkm/usaid-kenya_stoves2010.pdf.
[24] Also known as *upesi*.
[25] Gitau, G. C. (2011), 'The GIZ Dadaab Household Energy Project', presentation during 'Improved Cookstove Colloquium' held at Nairobi Sarova Panafric, 7 June 2011, GIZ Kenya Programme, https://energypedia.info/images/5/54/The_GIZ_Dadaad_Household_Energy_Project.pdf.
[26] www.lifelinefund.org/work/haiti/.
[27] www.cookstoves.lbl.gov/darfur-archives.

- The US firm InStove was contracted by the United Nations in 2011 to deploy institutional stoves to refugee camps. Over 300 of its units now serve school feeding programmes in Darfur, Ethiopia and South Sudan.[28]

New technologies have also been developed that can burn fuels in much cleaner ways. For example:

- Project Gaia supplied ethanol stoves and fuel to 3,500 households in the Jijiga refugee camp in Ethiopia.[29] This reduced firewood consumption, increased the security of women and children, and improved household air quality.
- The Norwegian Refugee Council (NRC) trained refugees in Ethiopia on the management of animal waste for biogas production,[30] with some systems incorporating bio-latrines to supplement animal manure feedstock.[31]

However, while biogas systems have been installed in refugee settings as both a sanitation and cooking fuel solution, their track record is not encouraging. For example:

- A biogas unit was installed close to the Sanischare refugee camp in Nepal, but the bio-latrines were overburdened, the use of biogas for cooking was a taboo and there were disagreements over the sharing of the gas supply.[32]
- An institutional biogas system installed in Port-au-Prince (Haiti), fed by 60 toilets and connected to a communal kitchen, was similarly problematic as 'the lack of a model with clear duties and benefits linked to the task of caring for them and maintaining the bio-digesters resulted in an overflow of sludge, and not enough gas was produced'.[33]

Box 1: Impacts of firewood needs on the environment

Refugees in the Jamam and Gendrassa camps in South Sudan used an average of 4.25 kg of firewood each day, leading to a dramatic depletion of forest resources near the camps.[a] Competition for fuel led to conflict and an increase in time spent collecting fuel, with women taking an average of four hours to gather firewood every two to three days.

In Kenya, the two large refugee complexes of Dadaab and Kakuma were set up in the early 1990s and currently have a combined population of 520,000.[b] Woodfuel was initially harvested within a 10-km radius, mostly by women and children, but this radius has since expanded to 70 km as refugees have used commercial hand carts, donkey carts and trucks.[c] Over the years, various cooking energy programmes have been introduced by UN agencies and partners. These have included organized firewood supply, although this provides for less than 20 per cent of actual consumption.

[a] ACTED (2013), 'Update of Energy Source Consumption and Trends Analysis in Jamam and Gendrassa Refugee Camps, Maban County, Upper Nile State, South Sudan', https://data.unhcr.org/SouthSudan/download.php?id=488.
[b] Otieno, P. and Gazarwa, D. (2014), 'Joint Assessment Mission – Kenya Refugee Operation, Dadaab (23–27 June 2014) and Kakuma (30 June–1 July 2014) refugee camps', WFP and UNHCR, http://www.unhcr.org/54d3762d3.pdf.
[c] Gitau (2011), 'The GIZ Dadaab Household Energy Project'.

[28] www.instove.org.
[29] www.projectgaia.com/files/AboutProjectGaia.pdf.
[30] Biogas is a mixture of different gases, primarily methane, produced by the breakdown of organic matter in the absence of oxygen.
[31] www.nrc.no/?did=9186732#.VdGEAflVhBc.
[32] Owen et al. (2002), *Cooking Options in Refugee Situations*.
[33] Bellanca, R. (2014), *Sustainable Energy Provision Among Displaced Populations: Policy and Practice*, Research Paper, London: Royal Institute of International Affairs, https://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20141201EnergyDisplacedPopulationsPolicyPracticeBellanca.pdf.

These experiences suggest that while biogas may be a viable technological option for meeting cooking and sanitation needs, it faces significant social and operational challenges.

- In Jordan, nearly 8,000 LPG cylinders were distributed by the UNHCR in the Azraq and Zaatari camps in 2014. Each family received a refill every four weeks for cooking and another every two weeks for heating. The cost to the UNHCR was around $50 per cylinder, and refills were around $14.[34] A voucher system was also introduced for the purchase of gas cylinders and other appliances.

Distinct features of the displacement setting

Many of the challenges and opportunities that drive the cookstoves sector in stable developing countries are equally relevant in displacement situations, while others are unique to the humanitarian context and require tailored approaches. A report on agency roles and responsibilities for fuel strategies in humanitarian settings notes the following challenges linked specifically to cooking:[35]

- Poorly ventilated shelters introduce a risk of HAP.
- Shelters in close proximity may cause extensive house fires.
- Competition for woodfuel, fodder and shelter materials causes tensions with host communities (with an associated risk of retributions or attacks).
- Increased collection distances waste time for women and children that could otherwise be used for education, leisure or other activities.
- Lack of clean and sustainable cooking solutions may lead to unsafe cooking practices and inadequate nutrition due to trading or sale of rations to acquire fuel, undercooking of food, skipping of meals and consumption of foods with low nutritional content. Refugees barter or sell up to 25 per cent of their food in Kakuma camp in Kenya, where firewood costs up to $20 per cartload.[36]
- On the other hand, woodfuel sales can become an important source of income for both refugees and hosts: up to 75 per cent of host community families at the same camp sell woodfuel to the refugees.

As host communities and displaced populations live in the same environment, the introduction of clean, modern cooking solutions has the potential to benefit both groups. However, displaced people are clearly not in the same situation as non-displaced people. Cooking solutions must recognize and respond to the differences between the two populations. Key differences, their implications and possible responses are summarized in Table 5.

[34] Direct communication with UNHCR, August 2015.
[35] The Inter-Agency Standing Committee (IASC) was established in 1992 to strengthen coordination of humanitarian assistance. It is formed by the heads of a broad range of UN and non-UN humanitarian organizations. See www.humanitarianinfo.org/iasc for a broad overview. For more detail on challenges linked specifically to cooking, see IASC (2009), 'Matrix on Agency Roles and Responsibilities for Ensuring a Coordinated, Multi-Sectoral Fuel Strategy in Humanitarian Settings', https://www.humanitarianresponse.info/system/files/documents/files/Matrix%20on%20agency%20roles%20and%20responsibilities.pdf.
[36] Otieno and Gazarwa (2014), 'Joint Assessment Mission – Kenya Refugee Operation. Dadaab (23–27 June 2014) and Kakuma (30 June–1 July 2014) refugee camps'.

Table 5: Factors differentiating cooking in displacement situations

Difference	Implication	Possible approaches
Displaced people have limited access to finance because they are not allowed to work, cannot find work or are paid less.	Limited spending power constrains purchase of better stoves and fuel (e.g. in South Sudan, refugees were selling firewood and charcoal for cash, but not buying efficient stoves because of cost).	• Investigate bulk stove purchase to cut costs, perhaps providing credit to incentivize distributors. • Explore carbon finance to reduce stove costs. • Distribute cash or vouchers for acquisition of goods in the open market.
Displaced people may be restricted from accessing local energy sources by host communities or government regulations.	Reliance on purchase of fuel or risky self-sourcing negatively affects fuel affordability and quality.	• Establish or strengthen community management structures that permit access to resources within a controlled framework (specific days, locations and harvesting methods).
Displaced people may feel dependent on humanitarian agencies for meeting basic needs, a feeling perpetuated by handouts. Refugees have the potential to create diverse economic opportunities.[a]	Dependency means solutions are constrained by humanitarian budgets. This results in low prioritization of modern cooking.	• Encourage commercial activities by displaced people and interaction with the host country's economy. • Reassess cooking in the humanitarian context as an integrated package involving food and fuel, with budgets to match.
Encampment policies prevent displaced people from moving to procure materials and merchandise or sell their products, undermining commercial and productive activities.	Dependence on external support is increased and opportunities for self-reliance are reduced.	• Engage in high-level dialogue with host governments to highlight missed opportunities from encampment policies and movement controls.
Local people and host governments resent efforts that result in displaced people receiving better stoves and fuels than hosts.	Where local people use solid fuel in inefficient appliances, it may be insensitive and politically difficult to leapfrog to high-tech solutions for the displaced population.	• Develop integrated programmes supporting both displaced people and host communities. • Avoid high-tech solutions unless equally accessible to local people.
Relief agencies seem reluctant to develop market dynamics in their projects.[b] Recognizing displaced people as a potential resource and market opportunity might indicate an unwelcome sense of permanence that governments do not wish to convey to citizens.	Without market dynamics, humanitarian operations will remain dependent indefinitely on donation and subsidy.	• Market led solutions such as PAYG, micro-enterprise and outsourcing labour from camps offer a stronger basis for energy sustainability.[c]
Multiple agencies operate in displacement settings, particularly in the emergency phase, often outside mainstream government structures.	Complex mix of agencies, NGOs and donors makes coordination and common approaches challenging.	Ensure early-stage coordination of humanitarian actors, ideally led within government, to ensure consistency of approach and avoid duplication. Possibly designate a single agency to handle improved cooking.

[a] Betts, A., Bloom, L., Kaplan, J. and Omata, N. (2014), *Refugee economies: Rethinking popular assumptions*, University of Oxford Humanitarian Innovation Project, http://www.rsc.ox.ac.uk/files/publications/other/refugee-economies-2014.pdf.
[b] Bellanca (2014), *Sustainable Energy Provision Among Displaced Populations*.
[c] Ibid.

On the positive side, the high profile of humanitarian operations and the specialized funding they attract may mean that displaced people and their hosts can benefit from the support of cutting-edge international organizations with access to the latest clean cooking technologies and state-of-the art technical expertise, which would not otherwise be available in the area. This has certainly been the case with a wave of carbon-financed stove organizations entering the humanitarian sector with the latest cookstove models. Displaced people are also frequently concentrated in camps or settlements where new ideas or technologies can be disseminated quickly and cost-effectively, enabling high impacts to be achieved with finite resources.

Policy and support

Despite the clear differences between the humanitarian context and situations in stable communities, it is important to avoid treating their respective populations dramatically differently. This risks creating tensions and accusations of inequitable treatment. While it is often assumed that humanitarian emergencies will be short-lived and therefore do not justify long-term solutions, this rarely proves to be the case. Evidence suggests that the average length of time spent as a refugee is 17 years.[37] It is therefore helpful to integrate humanitarian operations in any ongoing national processes for the promotion of clean cooking solutions. Examples of this would be the application of the Global Tracking Framework for cooking fuel and technology use in humanitarian operations, or support to commercial promoters of cookstoves to encourage them also to work in displaced communities. At present such crossover is hindered by a silo-style approach in which humanitarian support is delegated to specialized actors (such as the UNHCR, World Food Programme and relief organizations, working with humanitarian counterparts in host governments) outside the mainstream of national development processes. So while a country's energy ministry might be working on clean cooking solutions with the GACC, the national bureau of standards, and commercial investors, these experiences will rarely extend to humanitarian work as this is seen as a transitory situation and the responsibility of different government institutions and the donor community. This perspective is clearly unrealistic when displacement is still being managed as a temporary phenomenon 25 years later (e.g. in Kenya's refugee camps).

> Evidence suggests that the average length of time spent as a refugee is 17 years. It is therefore helpful to integrate humanitarian operations in any ongoing national processes for the promotion of clean cooking solutions.

Expanding ongoing programmes for improved cooking to the humanitarian setting may be appropriate in countries with a well-developed clean cooking sector. If, on the other hand, the host country is characterized by inefficient, polluting cooking systems and has no significant modern cooking initiatives under way, it would be incongruous and unsustainable to promote highly sophisticated approaches for displaced people in isolation. Efforts to improve cooking systems in such settings risk becoming isolated short-term initiatives, so there may be justification for a less advanced approach more in line with national realities.

The cooking priorities of displaced people may also not correspond with those of the humanitarian agencies that support them. They will usually be less likely to see emissions as a significant problem, for example, and will probably place higher priority on stove usability and running cost. This demands a sophisticated approach from humanitarian agencies in which the limits of technological interventions are well recognized, and the need for coordination with other non-technical stakeholders is acknowledged.

[37] UNHCR (2014), 'Global Strategy for Safe Access to Fuel and Energy (SAFE) – A UNHCR Strategy 2014–2018', http://www.unhcr.org/530f11ee6.html.

Summary

The increasing sophistication and quality of cooking solutions in the global market has been mirrored by developments in the humanitarian sector.

Many of the challenges faced in stable communities and displacement situations are similar, and it is important to transfer best practice where possible.

Nevertheless, some challenges and opportunities are unique to the humanitarian context and require adapted approaches. Key differences include limits on access to finance and permission to work, controls on movement and resource use, a governance dichotomy between displaced people and hosts, a dependency culture that inhibits self-reliance and constrains market-based solutions, and a multiplicity of actors focused largely on short-term humanitarian response.

Such differences may require new approaches from the humanitarian community and host governments, particularly in facilitating engagement with local and national economies, and in involving new and different stakeholders.

5. The Market Systems Model in Humanitarian Settings

Introduction

Recognizing the importance of integrating food, fuel and cooking within a humanitarian response, interventions need to respond appropriately to the specific context of each displacement setting. A number of agencies have developed tools for carrying out situation assessments around cooking systems and energy needs. One prominent example is the Safe Access to Fuel and Energy (SAFE) Strategy and accompanying toolkit developed by a network of humanitarian agencies.[38] The FAO also integrates cooking fuel assessments in its post-disaster planning by investigating existing uses of energy for cooking and other purposes, cooking devices and conservation practices being used, energy consumption levels and costs, environmental impacts, risks, challenges and institutions engaged.[39] The findings feed into an integrated package of energy, environment and livelihood-related responses. A selection of other approaches and toolkits for assessing household energy situations is described in Annex F.

A potential drawback of some assessment approaches is that they tend to consider humanitarian operations as self-contained programmes of limited duration. The previous section noted the likely longevity of displacement and the benefits of positioning humanitarian support within the broader development context of the hosting country, and the risks and missed opportunities of stand-alone cooking programmes that are seen only as part of a humanitarian response package. To that end, the Market Systems Model described below offers a framework for analysing how energy services are provided within the larger market system, and how cooking solutions for displaced populations can be productively integrated within the wider economy of the hosting country.

The Market Systems Model

Market mapping has been used to guide energy provision in humanitarian settings for a number of years (see Box 2).

A more elaborate framework for system mapping in energy markets has been developed by the European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) and Practical Action.[40] As a tool for understanding energy markets and planning relevant interventions, it can be used in displacement situations to inform the design of better and more sustainable cooking interventions that link to existing national markets for fuels and cookstoves.

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38 www.safefuelandenergy.org.
39 FAO (2013), 'Safe access to firewood and alternative energy in humanitarian settings', FAO in Emergencies Guidance Note, http://www.fao.org/fileadmin/user_upload/emergencies/docs/Guidance%20Note%20Safe.pdf.
40 See Franz, M. et al. (2015), *Building Energy Access Markets. A Value Chain Analysis of Key Energy Market Systems*, European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF), www.practicalaction.org/media/download/48192.

Box 2: Emergency Market Mapping and Analysis tool

Practical Action developed the Emergency Market Mapping and Analysis (EMMA) tool to help humanitarian agencies analyse markets to identify appropriate emergency and early recovery responses.

The EMMA tool has four strands: gap analysis, baseline mapping, emergency mapping and response analysis.[a] The tool was used to explore the programming options to meet the fuel needs of over 50,000 individuals displaced by conflict in camps near Peshawar, Pakistan. The local firewood market chain was mapped before and after the crisis, including identification of price jumps, changes in volume and other characteristics. Surveys, focus groups and interviews were conducted with households, key informants, market actors, regulatory bodies and civil society. Based on the EMMA assessment, the team considered introducing vouchers and cash options for refugees to acquire firewood. It also proposed LPG cylinder refills and a fuel-for-school attendance option for students. Improved cooking stoves were introduced and, over the longer term, it was recognized that reforestation and governance of the firewood industry would also be important interventions.[b]

[a] Mohiddin, L. and Albu, M. (2015), 'Emergency Market Mapping and Analysis (EMMA) tool', ENN Online, www.ennonline.net/fex/35/emergency.
[b] Goluba, D. and Montgomery, K. (2011), 'Value chains in emergencies: Firewood for Internally Displaced People', HEDON, 2011, http://www.hedon.info/tiki-download_item_attachmnt.php?attId=382.

Structure of the model

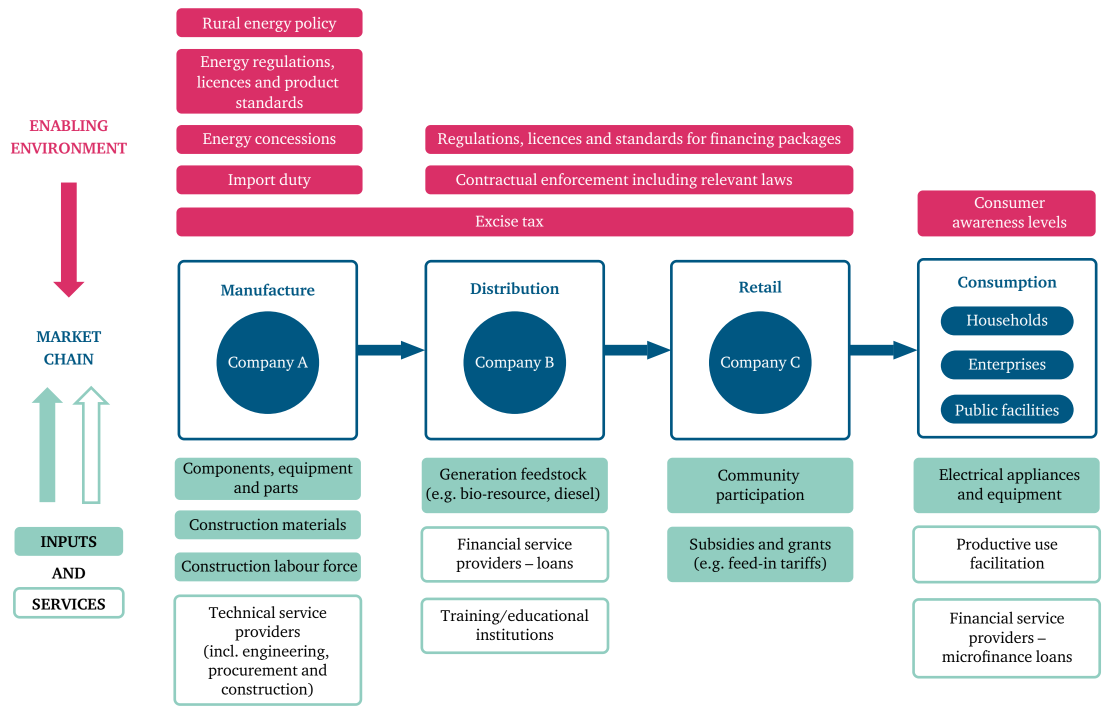
The Market Systems Model developed by EUEI PDF and Practical Action has two main stages.

Stage 1 entails the mapping of the energy market system at three levels:

- **Market mapping:** Map out the entire market chain, identifying all market actors at the stages of manufacturing, distribution, retail and consumption. These are the companies and individuals that own the energy services being delivered. Some actors may occupy more than one market sector (e.g. both manufacturing and distribution).
- **Enabling environment mapping:** Map out the factors that affect each actor within the four market sectors. These are the factors or forces that affect the activities of actors in either a positive or negative way, but that are not within their direct control. Such factors might include quality control standards for particular products, specific policies or regulations, tax incentives for energy appliances and equipment, and levels of contractual enforcement of energy contracts with households and companies.
- **Supporting services and inputs:** Map out the supporting inputs and services required by each of the market sector actors. Inputs are the physical materials and resources that are required by each actor, such as energy fuels, hired labour and electrical appliances; while services are the paid-for activities – such as market research, technical capacity-building and financial services – that other actors provide to help market actors deliver their part of the market.

The result from Stage 1 is a market systems map resembling the generic example in Figure 3.

Figure 3: Generic market systems map

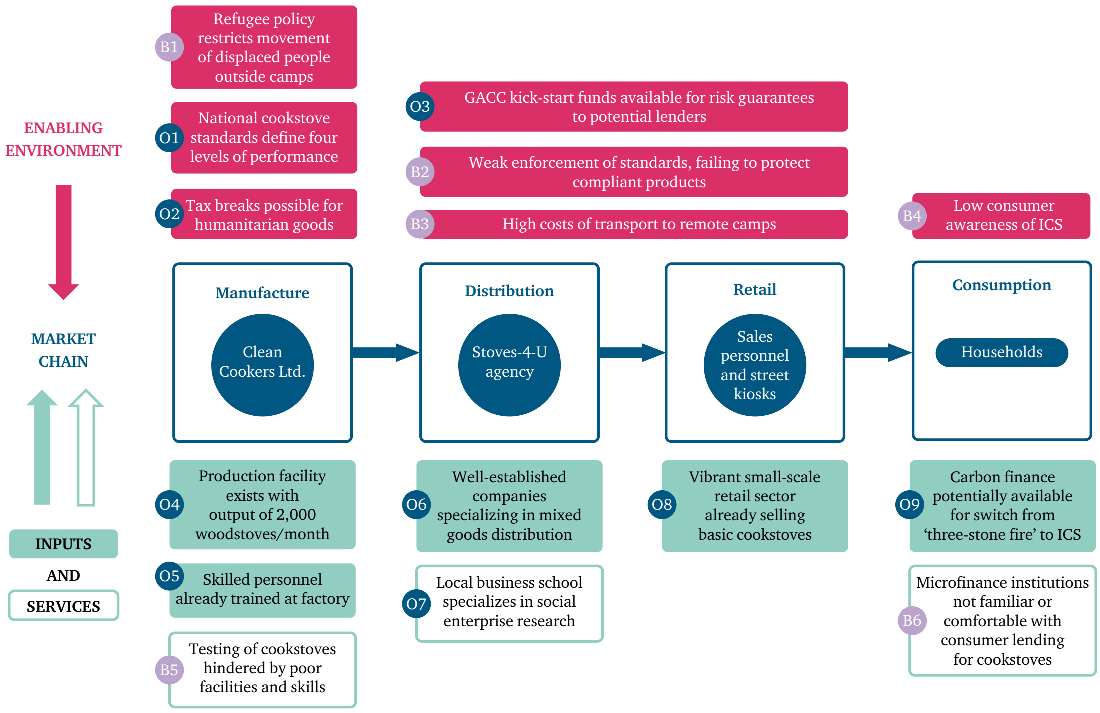


Stage 2 of the approach is to identify the main challenges and opportunities at each stage in the market chain and across the three levels, and to design supporting interventions that respond appropriately. A challenge might be a policy that is not enacted or a tax incentive that does not help the poor access modern energy services, whereas an opportunity might be the existence of approved quality standards for cookstoves that need support for enforcement.

Example from the humanitarian setting

Figure 4 shows an example of a market systems map based on the EUEI PDF model that relates to woodstoves for potential promotion in a humanitarian setting. In this hypothetical scenario, a (fictional) company that already exists in the hosting country is manufacturing high-grade woodstoves for the local household market. A number of opportunities (O) and barriers (B) are highlighted that could facilitate or hinder the successful extension of the company's commercial operations to refugee camps where the displaced population is accommodated.

Figure 4: Sample market map for woodstove market chain in refugee-hosting country



Having identified potential market barriers and opportunities (Stage 1), responsive interventions need to be designed (Stage 2). Each intervention should either support market chain actors directly, or provide the necessary supporting inputs, services or enabling environment. Table 6 indicates possible interventions for the woodstove scenario above.

Table 6: Potential interventions arising from the identified market barriers and opportunities

		Barrier or opportunity	Potential intervention
Barriers	B1	Refugee policy restricts movement of displaced people outside camps	Evidence-based, high-level dialogue with national authorities on potential benefits of refugee movement and participation in economy, under controlled conditions
	B2	Weak enforcement of cookstove standards, failing to protect compliant products	Support for branding, marketing and certification (e.g. sticker system) to indicate compliance
	B3	High costs of transport to remote camps	Piggyback model using existing distributors of household commodities; risk financing for distributors to extend operations to camps
	B4	Low consumer awareness of ICS	Support for sales and marketing (mass media, roadshows, promotions, etc.)
	B5	Testing of cookstoves hindered by poor facilities and skills	Support testing facility (e.g. laboratory) at national bureau of standards or other appropriate institution
	B6	Microfinance institutions not familiar or comfortable with consumer lending for cookstoves	Develop risk financing products for microfinance institutions

		Barrier or opportunity	Potential intervention
Opportunities	O1	National cookstove standards define four levels of performance	Opportunity to promote cookstoves to consumers and financiers as measurably cleaner and more modern options
	O2	Tax breaks possible for humanitarian goods	Opportunity to apply for tax break on raw materials for cookstoves, or on stoves for humanitarian operation
	O3	GACC kick-start funds available for risk guarantees to potential lenders	Potential for microfinance institutions to apply for funds to de-risk micro-loads for cookstoves
	O4	Production facility exists with output of 2,000 woodstoves/month	Capacity already available to manufacture stoves in bulk that suit local conditions, assuming fit with refugee diet and culture
	O5	Skilled personnel already trained at factory	No need to train production teams or set up new facility
	O6	Well-established companies specializing in mixed goods distribution	Opportunity to apply piggyback distribution model
	O7	Local business school specializes in social enterprise research	Opportunity for student research in customer tracking and sales analysis using apps and mobile phone tools
	O8	Vibrant small-scale retail sector already selling basic cookstoves	Consumers already aware of potential to switch cooking systems
	O9	Carbon finance potentially available for switch from ‘three-stone fire’ to ICS	Opportunity to use carbon finance for marketing and distribution support

Conclusion

While this highly simplified example focuses on one market chain only, it illustrates the potential application of the Market Systems mapping approach for systematically considering each aspect of a value chain and identifying where, and how, the potential for intervention exists to integrate the displaced community in the national cooking economy.

The Market Systems Model methodology can be used in the humanitarian setting to understand the dynamics of both the internal and external environment, and to design interventions accordingly. Analysing the socio-cultural influences of using particular cooking technologies and fuels, the delivery market chain and the various supporting services applicable can enable those interventions to be designed more sustainably and appropriately for the needs of the displaced population and impacted communities. Mitigation measures, such as increased budgets for raising awareness, subsidies in the delivery chain for clean cooking technology interventions, or the introduction of refuelling stations or voucher systems for stoves and fuel, are examples that could become part of an appropriate intervention package.

Summary

Recognizing the importance of integrating food, fuel and cooking within a humanitarian response, interventions need to respond to the specific context of each displacement setting.

A number of agencies have developed tools for carrying out situation assessments around cooking and energy. However, these generally consider the energy needs of the humanitarian setting in terms of a distinct, time-limited relief operation.

The Market Systems Model methodology offers a means of integrating cooking solutions in the humanitarian setting with national processes, institutions and the wider energy economy.

6. Conclusions

Cooking is central to human survival and family well-being, and will continue to be an integral element in dealing with any mass displacement of people. If it is neglected by the humanitarian community, then the default option for displaced populations is likely to be unsustainably sourced solid fuels that are burned in an unhealthy way using inefficient appliances or on open fires, with inevitable impacts on health, well-being and security. The opportunity exists to avoid this outcome, if humanitarian agencies and host governments classify cooking solutions as a priority, invest appropriate resources and learn from the wide experience that has been accumulated in the development sector.

The international cookstoves sector is vibrant, with an abundance of firms offering clean, modern cooking solutions of potential benefit both to displaced people and to the wider economies of the countries that host them. Incorporating the experience and expertise of this sector into humanitarian programming requires new perspectives on the part of international relief agencies and host governments.

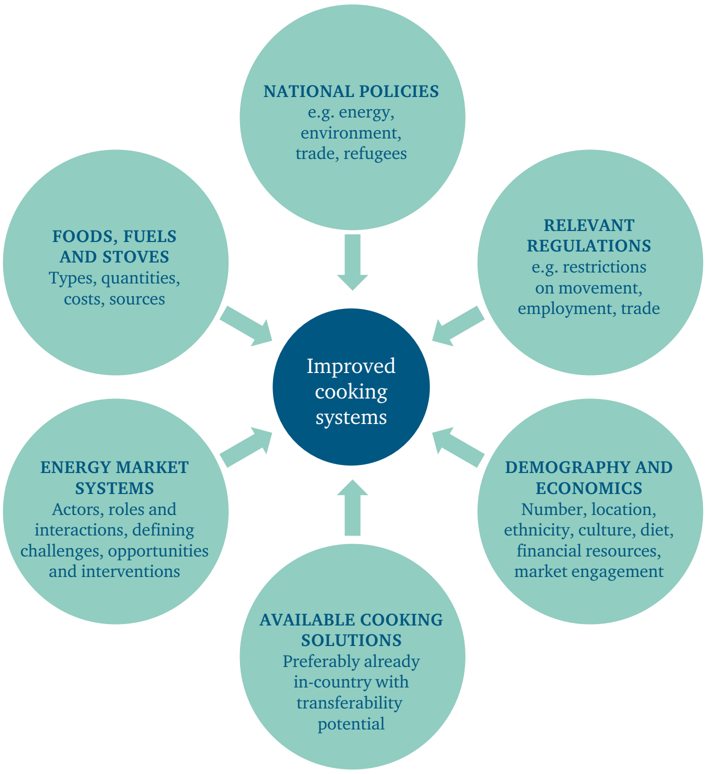
If cooking is neglected by the humanitarian community, then the default option for displaced populations is likely to be unsustainably sourced solid fuels that are burned in an unhealthy way using inefficient appliances or on open fires, with inevitable impacts on health, well-being and security.

The shift in approach may, in part, require higher budgets; the annualized cost of clean, modern, efficient cooking has been estimated in this paper at $21–30 per person with intermediate and improved solid-fuel stoves. These average prices could drop if humanitarian operations adopted a more consistent, large-scale approach to the promotion of improved cooking systems.

A new perspective also requires the integration of humanitarian operations and displaced people into mainstream development and national economies, so as to minimize dependency and isolation. Treating displaced people as a discrete population whose movement is constrained and who are obliged to rely on handouts from the international community means that they cannot become properly integrated in national energy economies; cannot share their skills, expertise and labour; become dependent indefinitely on donations; and become a permanent burden on public funds. The preferable alternative is to incorporate displaced people in local and regional economies and energy markets, to build upon and extend national clean cooking initiatives to cover camps and settlements where displaced people reside, to capitalize on their skills and labour to energize local economies, and to promote clean cooking solutions among both displaced people and host communities with equal commitment. As far as possible, private-sector approaches should be transferred to the displacement setting, with displaced people empowered to become economically productive consumers and to avoid subsidies and donations that are ultimately not sustainable.

This toolkit does not prescribe particular solutions, but instead highlights key considerations in the introduction of improved cooking systems in humanitarian operations. These considerations are summarized in Figure 5 below, which can be seen as an abridged guide to assessment and implementation in the humanitarian setting.

Figure 5: Key considerations in the design of improved cooking systems in humanitarian operations



Annex A: Pros and Cons of Main Cooking Fuels

Fuel type	Fuel	Pros	Cons
Solid	Firewood	• Often widely available, particularly in rural areas • Can be produced locally and is conditionally renewable • Production costs can be very low • Can be smoke-free if dried and efficiently burned • Familiar and easy to use	• Needs to be dried and processed into small pieces for low emissions and high efficiency • If not, burns inefficiently and produces high emissions • Fuelwood plantations rarely the most economically attractive option for landowners • Costly to transport due to relatively low energy density
	Charcoal	• Potentially renewable if sources are sustainably managed • Local cash benefits and employment • Relatively low emissions • Can be burned efficiently and safely with right stove • Popular and convenient for users • Lower transport costs than firewood per unit of energy	• High energy losses from raw wood to final product • May be associated with environmental degradation at large commercial scale
	Briquettes	• Potentially renewable using biomass residues • Homogeneous and standardized	• Tends to be costly per unit of energy • Unfamiliar to users • Inferior burning qualities (e.g. higher ash) • May require special stoves • Can be hard to source bulk supplies
	Coal	• Cheap in some countries • Relatively high heat value	• High emissions (greenhouse gases and black carbon) • Dirty and dusty to transport and handle
Liquid	Kerosene	• Often available through existing distribution systems, even in remote areas, due to popularity for lighting • Can be burned cleanly and efficiently in pressurized stove. • Convenient and quick to use	• Non-renewable • Often imported, depleting foreign exchange and reducing energy security • Needs special stove • Dirty and unhealthy in wick stoves • Potentially lethal in wick stoves (heats to flash point, explodes on spillage) • Risky to transport, distribute and store • Users may sell and revert to woodfuel
	Ethanol	• Clean cooking with low emissions • Production can contribute to local economy and jobs • Relatively easy to use; heats up quickly	• Low heating value, especially with gel additives • Needs special stove • Costly to produce and distribute
	Other biofuels	• Relatively clean-burning • Lower lifecycle greenhouse gas emissions • Can be produced locally, supporting rural development	• Usually costlier than fossil fuels • Potential conflict with food production • Infrastructure costly for large-scale production

Fuel type	Fuel	Pros	Cons
Gaseous	LPG	• Clean, fast and safe to use • No smoke or soot • Heats instantly and easily adjusted • Can be transported in bulk and stored in small units	• Non-renewable • Significant outlay to refill cylinder • Usually imported, depleting foreign exchange and reducing energy security • Needs special stove • Potential for leakage from old and poorly maintained cylinders • Distribution infrastructure expensive and difficult to manage • Supply chain unreliable
	Biogas	• Clean-burning; no smoke • Easy to use and control • Flexible sizing to fit demand • Can be integrated with sanitation management	• High capital cost • High water and feedstock requirements • Potentially high maintenance needs
Other	Electricity	• No emissions at point of use • Low greenhouse gas emissions if generated from renewable sources • Easy to manage heat • Relatively safe	• More expensive than other fuels, especially if sourced from generator • Absent or unreliable in rural areas, where displaced people are often located • Needs special stoves
	Solar	• Renewable and clean • Fuel is free, though the stove can be expensive • Minimal maintenance of cooker	• High socio-cultural barriers, including need to cook outside during middle of day • Requires continual realignment, especially for high-performance model • Cannot fry or roast • Needs extensive awareness-raising and training

Annex B: Cookstove Performance Tiers

These tiers were defined by the GACC 2012 International Workshop Agreement, which underpins the ongoing process of ISO standards development. The tiers are associated with the Water Boiling Test v. 4.2.3 and the Biomass Stove Safety Protocol v. 1.1.[41]

Emissions – CO		
	High power CO (g/MJd)*	Low power CO (g/minute/litre)
Tier 0	>16	>0.20
Tier 1	≤16	≤0.20
Tier 2	≤11	≤0.13
Tier 3	≤9	≤0.13
Tier 4	≤8	≤0.09

* grams per megajoule delivered to the pot

Emissions – $PM_{2.5}$		
	High power $PM_{2.5}$ (mg/MJd)*	Low power $PM_{2.5}$ (g/minute/litre)
Tier 0	>979	>8
Tier 1	≤979	≤8
Tier 2	≤386	≤4
Tier 3	≤168	≤2
Tier 4	≤41	≤1

* milligrams per megajoule delivered to the pot

Indoor emissions		
	Indoor emissions CO (g/minute)	Indoor emissions $PM_{2.5}$ (mg/min)
Tier 0	>0.97	>40
Tier 1	≤0.97	≤40
Tier 2	≤0.62	≤17
Tier 3	≤0.49	≤8
Tier 4	≤0.42	≤2
Efficiency/fuel use		
	High-power thermal efficiency (%)	Low-power specific fuel consumption (MJ/min/l)
Tier 0	<15	>0.050
Tier 1	≥15	≤0.050
Tier 2	≥25	≤0.039
Tier 3	≥35	≤0.028
Tier 4	≥45	≤0.017
Scale of 0 to 100*		
Tier 0		<45
Tier 1		≥45
Tier 2		≥75
Tier 3		≥88
Tier 4		≥95

* Points from 10 weighted safety parameters

[41] See GACC, 'Protocols', www.cleancookstoves.org/technology-and-fuels/testing/protocols.html.

Annex C: Major Cookstove Suppliers

This annex lists a selection of suppliers of factory-made cookstoves from around the world, but is not an exhaustive list and implies no endorsement of any particular product.

- **African Clean Energy (ACE) Ltd** www.africancleanenergy.com. A family-owned company in Lesotho employing around 60 people. Its gasifier stove is branded the 'ACE 1' and includes features for lighting and for charging low-power devices.
- **Biolite** www.biolitestove.com. A social-impact company that has developed the HomeStove, a modification of the rocket stove developed by the Aprovecho Research Center (US). Biolite's wood-burning stoves allow charging of portable electronic devices and are marketed as reducing indoor smoke by up to 90 per cent and eliminating up to 2.5 tonnes of greenhouse gases per stove per year. Its stoves are sold in India, Ghana and Uganda for around $40 (2014 estimate) with a one-year warranty and projected five-year lifespan.
- **Climate Management Ltd** www.climatemanagement.de. A private company in Lusaka, Zambia that focuses on Clean Development Mechanism (CDM) and other carbon projects. It distributes the 'Save 80' stainless steel stove, which includes a set of customized cooking pots. 185,000 units have been distributed across 12 African countries, including via the UNHCR in Chad.
- **CookClean Ltd** g7137002.wix.com/cookclean. A private company in Accra, Ghana. CookClean's charcoal stoves are registered under a CDM project. The stove consists of mild steel sheet with an embedded pot skirt. The combustion chamber for charcoal has a conical shape.
- **Dometic Group Ltd** www2.dometic.com/3bd0d450-1131-4f8f-8ce7-90e8283815e0.fodoc. A Swedish company that manufactures a variety of home appliances. Dometic has developed stoves that use ethanol or methanol, the Clean Cook M1 and Clean Cook M2, with one and two burners respectively. These have been introduced by the UNHCR in refugee camps in Ethiopia. The stoves were chosen for the Gaia Project's Global Clean Cooking Fuel Initiative, and in 2008 Gaia was awarded an Ashden Energy Award and an EU Energy Globe Award. It is reported that approximately 2 million Dometic stoves are in use.
- **Eco Stories** www.ecostoriesbd.com/ics.html. A private company in Dhaka, Bangladesh that produces the Apon *chulah* (stove). It consists of a stable base to support large pots, and is portable for outdoor and indoor use. It can use a range of biomass fuels, including charcoal, pellets, firewood and crop residues. Eco Stories is one of the most active companies in the Bangladesh ICS market and is a partner of the USAID programme 'Canalizing clean energy in Bangladesh'.
- **EcoZoom** www.ecozoomstove.com. A social enterprise manufacturing and distributing charcoal and woodstoves. The company has six designs for the international market. In Kenya, its best-selling product is the charcoal stove, which retails for approximately $45, with cash and credit options. Woodstoves retail at approximately $28 (24 cm top) and $33 (28 cm top) (prices as of August 2015).
- **Envirofit** www.envirofit.org. Founded in 2003, Envirofit was one of the first social enterprises to produce high-performing biomass cookstoves. The company partnered with the Shell Foundation

to create a viable business and has sold more than 850,000 stoves across 45 countries. The company markets over 10 different stoves for wood, charcoal and LPG, with most estimated to last approximately five years.

- **First Energy Ltd** www.firstenergy.in. First Energy was launched by BP in 2005 and later became an independent organization owned by Indian investors. First Energy focuses on gasification for domestic and commercial cooking. Its main small application product is the Oorja K30 DLX, a fan-powered stove with a rechargeable battery. The combustion chamber is made of metal-clad ceramic, with a stainless steel heat shield. First Energy has also developed institutional cookstoves.
- **Fortune Cooker Sustainable Energies** www.thefortunecooker.com. The Fortune Cooker solar cooking technology, developed by a Dutch company, allows the inclusion of a small photovoltaic panel for low-power applications. Similar to other solar cooking technologies, it is relatively expensive but can deliver significant fuel savings.
- **Huamei International Green Energy Holding Co. Ltd** www.huameienergy.com. This Hong Kong company develops biogas-related technologies including biogas recovery, storage, household anaerobic digestion and biogas appliances. It sells the following biogas appliances: single biogas stove; twin biogas stove; small biogas rice cooker; medium biogas rice cooker; water heater. Huamei currently markets its products in China, Thailand and some African countries, and also provides customer advice on CDM opportunities.
- **InStove Solutions** www.instove.org. This non-profit company designs, manufactures and distributes institutional stoves and has worked with the UNHCR and World Food Programme. Its main cookstove comes in 60-litre and 100-litre versions, with an integral aluminium pot, lid and chimney. The manufacturer claims that the combustion chamber withstands operating temperatures above 1,100°C.
- **Obamastove Ltd.** Originally established by a refugee, this company focuses on the Ethiopian market. It manufactures low-cost, handmade stoves, mostly with ceramic liners inside riveted sheet-metal cladding. Due its low cost, the Obamastove has potential for high take-up.
- **Philips.** This leading household appliance company has been involved in cookstove development for over a decade. It has been positively received in Africa and Asia, where two models have been distributed (HD4008 and HD4012, the latter being an upgrade of the former). These stoves are made of stainless steel and have an inner ceramic combustion chamber. The enhancement of the air/gas mixture by a fan facilitates more complete combustion, thus significantly reducing smoke. The battery to power the fan can be charged from the grid or a solar charger.
- **Potential Energy.** This company has its roots as a humanitarian organization in Sudan, but is now an established social enterprise wholesaler and retailer. Its stoves are designed by the Lawrence Berkeley National Laboratory, and the company has distributed over 42,000 units in Sudan and Ethiopia. They are manufactured in India in flat kit form and assembled in Sudan. The stove is usually provided for free, but is also sold through a network of local women's organizations with flexible payment plans.

- **Prakti** www.praktidesign.com. Prakti is a leading Indian cookstoves design, manufacturing and distribution company. It has eight stove types and has distributed over 8,000 household stoves and 880 institutional stoves in India, Nepal, Sudan, Haiti, the Democratic Republic of the Congo and Rwanda. The stoves have a lifespan of around five years, with prices ranging from $35 (household) to $800 (institutional).
- **Shengzhou Stove Manufacturer** www.ashden.org/international_finalists_2008. This Chinese manufacturing company, which works in partnership with the Aprovecho Research Center, has developed the low-cost StoveTec and is currently producing 12,000 units a month for distributors in South Africa, Tanzania, Madagascar, Argentina, Chile and the Marshall Islands. The StoveTec has a circular shape with an inner combustion chamber and handles for portability. In recognition of its impact and the innovative partnership model, Shengzhou and Aprovecho won the 2009 Ashden Award.
- **Solar Cooker Biz** www.solarcooker.biz. This American for-profit organization promotes solar energy for cooking. Its leading stove comprises a squared box with two cooking floors and an articulating reflector array. The cost of this technology is relatively high, though the company claims the cost can be recovered from fuel savings.
- **Toyola.** This stove manufacturing, distribution and retail company from Ghana has become a regional success. Toyola charcoal stoves with ceramic lining and metal cladding are sold across Ghana, Togo and Burkina Faso.
- **TTK Prestige Ltd** www.prestigesmartkitchen.com/cook-tops-and-chimneys/induction-cook-tops. This Indian company manufactures a range of induction stoves costing $40–100 (1,900 W single plate up to 2,900 W double plate). Though quite expensive, induction cookers are efficient, safe and clean for those with reliable and affordable electricity.

Annex D: Key Organizations in the Cooking Sector

Global initiatives

- **Climate and Clean Air Coalition** www.ccacoalition.org. Coalition led by the United Nations Environment Programme (UNEP) and the governments of Bangladesh, Canada, Ghana, Mexico, Sweden and the United States.
- **Global Bioenergy Partnership** www.globalbioenergy.org. Mainly promotes bioenergy for sustainable development, bringing together the public sector, private sector and civil society with climate change as one of its strategic areas.
- **Global LPG Partnership** www.glpgp.com. Aims to partner with developing countries to transition from cooking with solid fuels to LPG with a goal of 1 billion users by 2030. It expects to reduce by 4 million the annual deaths caused by cooking with solid fuels, in the process reducing deforestation and the human labour used in gathering fuel. Two funds accelerate this process: (i) the LPG Infrastructure & Distribution Fund; and (ii) the LPG First Costs Financing Fund.
- **Safe Access to Fuel and Energy (SAFE)** is a network of humanitarian agencies that includes the UNHCR, FAO, UNICEF, WFP, GACC, International Lifeline Fund, Mercy Corps, ProAct Network, Women's Refugee Commission and others. The Global SAFE Strategy for 2014–18 has the objectives of integrating energy in preparedness, response and implementation, improving access to household fuel, and 'establishing and managing woodlots for fuel provision and environmental protection', among others.[42] The coordination of agencies deploying energy solutions and the raising of funds are both important components of SAFE. The Strategy will be applied initially in 10 priority countries, where approximately 175,000 refugees are to be provided with stoves.[43] The Strategy recognizes that safe and reliable access to energy for cooking is a basic need and provides recommendations on interventions starting from the initial displacement process. Safeguarding women and girls from the risks of sexual and gender-based violence, often an issue with those who collect firewood, is also emphasized.
- **Sustainable Energy for All (SE4All)** www.se4all.org. A UN-supported initiative with various commitments on energy access, including clean cookstoves. Two 'High Impact Opportunity' areas have been developed for clean cooking: 'Clean Cooking Solutions' under the GACC; and 'Women and Health', led by the UN Foundation, WHO and UN Women.
- **World LPG Association** www.wlpga.org. The global voice for the LPG industry.

[42] UNHCR (2014), 'Global Strategy for Safe Access to Fuel and Energy (SAFE) – A UNHCR Strategy 2014–2018'.
[43] Ibid.

Multilateral institutions

The donor landscape for supporting clean cookstoves has been improving since the GACC was initiated. Key institutions include the following:

- **Food and Agriculture Organization of the United Nations (FAO).** The FAO has been engaged in fuel-efficient stoves from the 1990s (e.g. in Darfur), and primarily supports local partners to promote and distribute fuel-efficient stoves. The FAO has supported the distribution of thousands of stoves, and also developed standardized training. Its main response to cooking needs in emergency and recovery efforts is to focus on natural resource 'management and livelihood activities, contributing to increased resilience in crisis and disaster-affected areas' (together with the UNHCR, United Nations Development Programme and WFP).[44]
- **Global Alliance for Clean Cookstoves (GACC).** The Alliance has funded over 80 research and implementation projects since 2011, with a predominant focus on supporting individual market actors.
- **Office of the United Nations High Commissioner for Refugees (UNHCR).** One of the most important stakeholders, the UNHCR is 'mandated to lead and co-ordinate international action to protect refugees and resolve refugee problems' across the world, and to help stateless people.[45]
- **USAID, World Bank and UK Department for International Development (DFID).** Under USAID's Renewable Energy 'Leader with Associates' agreement, Winrock International[46] (an American NGO) carried out ICS studies in various countries (including Kenya and Bangladesh) and has started supporting ICS market chain actors in Kenya. The World Bank's ESMAP works closely with the GACC and USAID on frameworks and reports. Initial work has begun in Uganda to use 'results-based financing' to support the uptake of ICS's. DFID has been supporting the GACC, in particular, on gender and health research for ICS interventions.

Government and civil society organizations

Government-sponsored agencies and civil society organizations play a key role in the development of the cookstoves sector in research and development, capacity-building, market linkage and financing. The long list of organizations active in the sector includes the Aprovecho Research Center, FAO, Geres, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), Energising Development (EnDev), GVEP International, Lawrence Berkeley National Laboratory, Practical Action and SNV,[47] which have spearheaded cookstove design and promotional efforts over several decades.

Numerous country-level associations of cookstove promoters also exist, providing information, promoting standards and compliance, influencing policy, building capacity and providing support to members. For example:

[44] FAO (2013), 'Safe access to firewood and alternative energy in humanitarian settings', FAO in Emergencies Guidance Note.
[45] http://www.unhcr.org/pages/49c3646c2.html.
[46] http://www.winrock.org/.
[47] See www.aprovecho.org; www.geres.eu; www.giz.de/expertise/html/2769.html; http://endev.info/content/Main_Page; cookstoves.lbl.gov www.practicalaction.org; www.snvworld.org.

- Clean Cookstoves Association of Kenya
- Ghana Alliance for Clean Cookstoves[48]
- Nepal Alliance for Clean Cookstoves/Nepal Biogas Promotion Association
- Nigerian Alliance for Clean Cookstoves
- West Africa Alliance for Clean Cooking (WACCA)
- Vietnam Biogas Association

[48] http://www.cleancookstovesghana.org/.

Annex E: Cookstove Performance and Cost

The author gathered cookstove data from the GACC stove catalogue, HEDON stove database and studies by the UNHCR, GIZ, USAID and Chatham House, as well as from the websites of suppliers and manufacturers. Information on stove type, manufacturer, cost, lifespan and efficiency is presented in tabular form on the following pages, together with fuel requirements and – derived from this – the annualized cost of the stove plus cooking energy for one person.

The following notes apply:

1. Where information was unavailable on cost, lifespan or efficiency, the average value for other devices in the same category was used. These interpolated figures are shown in red text.
2. Cooking type is defined as either household (HH) or institutional (I), with the former assumed to cater for an average of five people per stove and the latter for 200 people.
3. For the purposes of calculating annual cooking fuel costs, it is assumed that one person requires 1.4 gigajoules (GJ) of energy per annum. This figure was extracted from the raw data used in Chatham House's economic analysis of energy provision to displaced populations, applying an average thermal efficiency of 36 per cent across the sampled cookstoves.[49]
4. The following energy costs have been assumed:

	Charcoal	Firewood	Compressed rice husks	Biogas	LPG	Kerosene	Pellets/ briquettes	Crop residues	Ethanol	Electricity
Unit of measurement	kg	kg	kg	kg	kg	kg	kg	kg	kg	kWh
Price per unit (US$)	0.180	0.065	0.180	0.000	2.475	1.284	0.100	0.020	1.00	0.70
Energy content (MJ/unit)	31.0	16.0	15.0	30.5	46.0	43.8	17.0	13.0	31.1	3.6
Energy price (US$/MJ)	0.006	0.004	0.012	0.000	0.054	0.029	0.006	0.002	0.032	0.194

Source: Energy prices from Lahn and Grafham (2015), *Heat, Light and Power for Refugees*, except ethanol and electricity. Current commercial rates for ethanol were applied, and a rate for electricity from diesel-powered generation (this being the most likely source of power in a humanitarian operation).

5. No discount rate has been applied.

[49] Lahn and Grafham, *Heat, Light and Power for Refugees.*

Summary of performance and cost data for leading cookstoves

Stove classification	Cooking type	Stove	Manufacturer/ designer	Principal fuel	Cost (US$)	Lifespan (years)	Annualized stove cost (US$/person)	Thermal efficiency (%)	Fuel required to deliver 1 MJ to food (units)	Fuel cost (US$/ unit)	Fuel cost to deliver 1 MJ to food (US$)	Annual fuel cost (US$/ person)	Total annualized cost, stove + fuel (US$/ person)
Legacy and basic ICS	HH	Anglo Supra Nova	Pemberton-Pigott and Desa	Firewood	7.43	4	0.22	29.0	0.22	0.065	0.01	20	20
	HH	ARTI Laxmi	Appropriate Rural Tech. Inst.	Firewood	7.43	4	0.28	18.2	0.34	0.065	0.02	31	32
	HH	Canamake Ivuguruye	Rwanda AJDR Cooperative	Charcoal	5.60	4	0.09	37.1	0.09	0.18	0.02	22	22
	HH	Ceramic Jiko	–	Charcoal	7.43	4	0.37	30.8	0.10	0.18	0.02	26	27
	HH	CookMate	CookClean Ltd	Charcoal	11.91	4	0.37	25.0	0.13	0.18	0.02	33	33
	HH	Mayon Turbo	Canada Resource Efficient Agric. Prod'n.	Crop residues	9	4	0.39	28.4	0.27	0.02	0.01	8	8
	HH	Obamastove	Obamastove Ltd	Firewood	6	3	0.25	34.0	0.18	0.065	0.01	17	17
	HH	Uhai	Practical Action	Charcoal	7.43	4	0.37	29.6	0.11	0.18	0.02	27	28
	HH	Upesi Portable	Practical Action	Firewood	4.63	4	0.14	20.7	0.30	0.065	0.02	27	28
Intermediate ICS	HH	Apon Chulah	Eco Stories	Firewood	30	4	1.07	30.5	0.20	0.065	0.01	19	20
	HH	BioLite HomeStove	BioLite	Firewood	55	4	1.38	32.3	0.19	0.065	0.01	18	20
	HH	CH-5200	Envirofit	Charcoal	60	5	1.39	36.1	0.09	0.18	0.02	23	25
	HH	Darfur Stove V.14	Potential Energy and Shri Hari Ind.	Firewood	9	5	0.30	25.7	0.24	0.065	0.02	22	22
	HH	Econochar	Envirofit	Charcoal	30	3	1.11	31.0	0.10	0.18	0.02	26	28
	HH	Econofire	Envirofit	Firewood	30	5	0.46	30.2	0.21	0.065	0.01	19	20
	HH	EzyChar	Ezy Life	Charcoal	57.50	3	2.40	33.0	0.10	0.18	0.02	25	28
	HH	EzyStove	Ezy Life	Firewood	100	3	3.33	27.1	0.23	0.065	0.01	21	28
	HH	G-3300	Envirofit	Firewood	60	5	1.39	32.6	0.19	0.065	0.01	17	20
	HH	GNG 2nd Generation	Good Neighbors Guatemala	Firewood	215	10	2.15	32.3	0.19	0.065	0.01	18	22
	HH	M-5000	Envirofit	Firewood	60	5	1.50	29.7	0.21	0.065	0.01	19	22
	HH	PCS-1	Envirofit	Firewood	33	5	0.83	36.5	0.17	0.065	0.01	16	17
	HH	Plancha HM-5000	Envirofit	Firewood	90	5	0.90	26.0	0.24	0.065	0.02	22	25
	HH	Prakti Single	Prakti	Charcoal	45	4	0.94	33.1	0.10	0.18	0.02	25	27

Stove classification	Cooking type	Stove	Manufacturer/ designer	Principal fuel	Cost (US$)	Lifespan (years)	Annualized stove cost (US$/person)	Thermal efficiency (%)	Fuel required to deliver 1 MJ to food (units)	Fuel cost (US$/ unit)	Fuel cost to deliver 1 MJ to food (US$)	Annual fuel cost (US$/ person)	Total annualized cost, stove + fuel (US$/ person)
Intermediate ICS	HH	Save80	Climate Management Ltd	Firewood	50	15	0.22	45.0	0.14	0.065	0.01	13	13
	HH	StoveTec GreenFire	Shengzhou Stove Manufacturer	Firewood	7.75	4	0.28	35.2	0.18	0.065	0.01	16	17
	I	EFI-100L	Envirofit	Firewood	90	5	0.06	45.7	0.14	0.065	0.01	12	13
	I	Rocket stove	InStove Solutions	Firewood	540	10	0.14	46.7	0.13	0.065	0.01	12	12
	I	Super Combined Instnl. Stoves	Botto Solar	Firewood	315	8	0.84	35.0	0.18	0.065	0.01	16	16
Advanced ICS	HH	ACE 1	African Clean Energy Ltd	Firewood	80	12	1.11	41.5	0.15	0.065	0.01	14	15
	HH	Belonio	Central Philippine University	Rice husk	112	3	4.67	32.8	0.20	0.18	0.04	51	59
	HH	Jinqilin stove	Shanxi Jinqilin Energy Tech. Co.	Firewood	100	5	4.00	12.7	0.49	0.065	0.03	45	49
	HH	Mwoto Quad2	Awamu	Firewood	20	1	1.67	37.5	0.17	0.065	0.01	15	19
	HH	Oorja	First Energy Ltd	Pellets	35	5	0.32	33.7	0.17	0.1	0.02	24	26
	HH	Philips HD4008	African Clean Energy Ltd	Pellets	31	4	1.11	33.9	0.17	0.1	0.02	24	26
	HH	Philips HD4012	Philips	Pellets	89	4	3.18	38.4	0.15	0.1	0.02	21	26
	HH	Vesto Stove	New Dawn Engineering	Firewood	100	5	3.33	32.0	0.20	0.065	0.01	18	22
Modern fuel stoves	HH	Prestige Induction Cooktop	TTK Prestige Ltd	Electricity	70	10	1.17	72.5	0.38	0.7	0.27	375	377
	HH	Pureflame	Envirofit	LPG	30	5	0.75	60.9	0.04	2.475	0.09	124	125
	HH	Télia n°2	Sodigaz APC	LPG	50	6	1.04	49.3	0.04	2.475	0.11	153	155
Renewable-fuel stoves	HH	All Season Solar Cooker	Solar Cooker Biz	Solar	99	15	0.55	n/a	n/a	0	0.00	0	1.3
	HH	Bio Moto	International Research & Development Africa Ltd	Ethanol	44	25	0.18	39.5	0.08	1	0.08	114	114
	HH	CleanCook	Dometic Group Ltd, Gaia Project	Ethanol	78	10	1.56	60.0	0.05	1	0.05	75	77
	HH	Cook up inox	ID Cook	Solar	190	10	3.80	n/a	n/a	0	0.00	0	3.8
	HH	F2-m	Montals Engineering	Biogas	44	4	0.44	49.8	0.07	0	0.00	0	2.2
	HH	Fortune cooker	Fortune Cooker Sustainable Energies	Solar	100	21	0.40	n/a	n/a	0	0.00	0	1.0
	I	Biogas rice cooker	Huamei International Green Energy Holding Co. Ltd	Biogas	315	14	0.90	49.8	0.07	0	0.00	0	4.5
	I	Generic biogas single stove	Norwegian Refugee Council	Biogas	315	14	0.90	49.8	0.07	0	0.00	0	4.5

Note: n/a indicates 'not applicable'.

Annex F: Toolkits for Household Energy Assessment

Catalysing Clean Cookstoves and Fuels Markets in Alliance Partner Countries
This GACC publication includes both tools and information to support the development and implementation of cookstove and fuel markets. www.cleancookstoves.org/resources_files/partner-country-toolkit.docx

GIZ guide to 'Cooking Energy in Refugee Settings'
www.energypedia.info/wiki/Cooking_Energy_in_Refugee_Situations

GIZ HERA Cooking Energy Compendium
A practical guidebook for implementers of cooking energy innovation. www.energypedia.info/wiki/GIZ_HERA_Cooking_Energy_Compendium

Household Air Pollution Intervention Tool (HAPIT)
HAPIT is a simple, web-based tool to compare the impacts of various cooking technologies on human health at national level, which can be used by policy-makers, donors, NGOs, project developers and researchers. hapit.shinyapps.io/HAPIT

Safe Access to Firewood and Alternative Energy (SAFE) in Humanitarian Settings
This is an FAO Emergencies Guidance Note focusing on natural resource management and livelihood activities related to displaced people's cooking needs, aiming to engender greater resilience in crisis- and disaster-affected areas. It includes a checklist that can be used for assessment and planning of SAFE measures by planners and practitioners. www.fao.org/fileadmin/user_upload/emergencies/docs/Guidance%20Note%20Safe.pdf

Set4Food: Decision Making Tool
This online tool is designed to assess a selection of appropriate food preparation technologies, based on the context of camps hosting refugees/internally displaced persons (IDPs). It is aimed at local staff operating at camp level. www.set4food.org/tools/decision-support-system-public

Set4Food Guidelines on Sustainable Energy Technologies for Food Utilization in Humanitarian Contexts and Informal Settlements
This document provides information and practical guidelines on how to implement energy technologies for food utilization in refugee/IDP camps. www.set4food.org/images/2015_Guidelines_SET4food_project.pdf

WHO Guidelines for Indoor Air Quality: Household Fuel Combustion
This tool for decision-makers provides technical recommendations about the performance of fuels and technologies used for cooking, lighting and heating, as well as guidelines for how to implement large-scale interventions. www.who.int/indoorair/guidelines/hhfc/en/

WHO Information on Cooking and Heating Practices

WHO has developed a set of questions and information cards for designing surveys on cooking and heating practices, which can be used by practitioners seeking to design appropriate interventions. www.who.int/indoorair/health_impacts/cooking/en/

Acronyms and Abbreviations

DFID	UK Department for International Development
EMMA	Emergency Market Mapping and Analysis
ESMAP	Energy Sector Management Assistance Program (World Bank)
FAO	Food and Agriculture Organization of the United Nations
GACC	Global Alliance for Clean Cookstoves
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GTF	Global Tracking Framework
HAP	household air pollution
HEDON	Household Energy Development Network
ICS	improved cookstove
IWA	International Workshop Agreement
LPG	liquefied petroleum gas
MEI	Moving Energy Initiative
NRC	Norwegian Refugee Council
PM	particulate matter
SE4All	Sustainable Energy for All
UNHCR	Office of the United Nations High Commissioner for Refugees
WHO	World Health Organization

About the Author

Mattia Vianello is an international energy consultant with Practical Action Consulting. He focuses on the analysis of a wider development context, including policy, regulations, markets and socio-economic aspects of energy access initiatives. During his time at Practical Action, Mattia has managed and delivered research and technical assistance in many countries in West Africa, East Africa, South Asia and Southeast Asia. He has been working for several international clients, including the World Bank, DFID, the United Nations Development Programme, the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), UNEP, the FAO and SNV. Prior to joining Practical Action, Mattia worked in Haiti as coordinator for an environmental programme in internal displaced camps and worked for Project Gaia, an NGO promoting ethanol cookstoves in Ethiopia. He holds an MSc in science and technology policy and management from the University of Edinburgh and a BA in philosophy from Vita Salute San Raffaele University in Milan.

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Cover image: A refugee woman from the Darfur region of Sudan prepares breakfast by her tent in the spontaneous overflow camp outside the Bredjing camp in neighbouring Chad, 29 August 2004

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