Research Paper

Rebecca Gunning

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The Current State of Sustainable Energy Provision for Displaced Populations: An Analysis

CHATHAM HOUSE

The Royal Institute of International Affairs

Contents

Summary

By the end of 2013, the number of forcibly displaced persons worldwide had reached 51.2 million, of which 33.3 million were internally displaced persons (IDPs) and 16.7 million were refugees. Access to energy is a basic human need; for these displaced people however, access to energy is a real challenge. This initial research reviews camp situations (which are home to approximately 50% of refugees) and focuses on the evidence of the benefits and impacts of sustainable energy access for displaced populations. The paper also assesses how the private sector could help to provide energy for displaced populations.

Large numbers of people in camps lack adequate access to sustainable energy; this has a negative impact on their lives. Despite numerous energy access initiatives over the years, the vast majority of displaced people still rely on traditional biomass and kerosene for cooking and lighting respectively. This can have significant impacts on the environment and on their well-being. Women and children in particular may be exposed to health and safety risks and have less time for education, livelihoods, social and other activities because of the time they need to spend collecting fuel.

Significant quantities of energy are also needed to power camp operations. Energy is needed for health centres, schools, water pumping, administration compounds and street lighting. This is currently provided by diesel generator sets, which cost the humanitarian agencies millions of dollars a year. Sustainable energy is increasingly recognized as an alternative, but it has not been mainstreamed by the agencies.

The provision of sustainable energy can reduce the negative impacts of the current strategies, offer opportunities for improved lives and economic progress, and reduce costs and environmental impacts. Yet the evidence of these impacts in camps is patchy, unsystematic and often anecdotal. The literature review shows that information is predominantly focused on stoves and that there are few studies which have independently assessed the impacts of sustainable energy actions in refugee or IDP camps. The findings do show that when improved cookstoves are appropriate, accepted and used correctly by users, they result in fuelwood savings and likely associated environmental benefits. Studies in different camps have also consistently reported that fewer fuelwood collection trips are made following the introduction of improved cookstoves. The World Food Programme found that the frequency of firewood collection is an important proxy for exposure to vulnerability to gender-based violence (GBV), with evidence suggesting that a reduction in the frequency of firewood collection may lead to a reduction in the vulnerability to GBV (WFP 2013b).

The uptake of improved cookstoves and solar lanterns can result in less household air pollution, as well as more time and cost savings for families, which allows them to spend more time on education or income-generating activities. Where sustainable energy reduces or offsets diesel, kerosene or firewood, improved cookstoves and solar lanterns can generate sizeable emissions savings. Energy efficiency and renewable energy can also significantly reduce humanitarian agencies' fuel bills and exposure to international fuel prices.

Only a limited number of monitoring mechanisms exist for sustainable energy projects in refugee camps. Further robust research is needed to investigate the links between sustainable energy interventions and the expected outcomes and impacts for displaced populations and camp management.

Appropriate sustainable energy solutions, and how they are delivered, are constantly evolving as technology develops and costs are reduced. This is creating new opportunities for sustainable energy provision in camps. One such opportunity, made easier by developments in smart meters and mobile money, is greater engagement with the private sector.

There are opportunities for the private sector to deliver these sustainable energy options effectively. Other than product supply, the largest role that the private sector currently plays in camps is in fuel supply. It is also engaged in informal micro-grids and mobile phone charging services. The greater involvement of market mechanisms in energy delivery is likely to result in more choice for the camp residents. A better understanding of the risks and the need for incentives to facilitate market-based mechanisms is needed before any new pilot projects are designed.

Introduction

The number of forcibly displaced persons worldwide has now reached 51.2 million. According to the United Nations High Commission for Refugees (UNHCR) 2013 Global Report, that figure includes 33.3 million internally displaced persons (IDPs), 50% of whom are under 18; 16.7 million refugees; and 3.5 million stateless persons.[1] Many are recently displaced. In 2013, the escalating conflict in Syria displaced an estimated 4.5 million persons, bringing the total number of Syrian IDPs to 6.5 million by the end of the year. Most are in 'protracted situations'; 61% of the refugees under UNHCR's mandate have been in exile for five years or longer.

Access to energy is a basic human need. Recognizing this, the proposed Sustainable Development Goals include a goal to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030 (Goal 7). This is just as true in humanitarian situations, where access to energy is even more of a challenge. The vast majority of displaced people rely on traditional biomass and kerosene for cooking and lighting respectively, which can have significant impacts on the environment and their well-being. This is particularly true for women and children, who may be exposed to health and safety risks and have less time for education, livelihoods, social and other activities because of the time they spend collecting fuel. Energy is also needed to power the camps' health centres, schools, administration compounds and street lights. This is currently provided by diesel generator sets, which cost the humanitarian agencies millions of dollars a year. The provision of sustainable energy can reduce the negative impacts of the current strategies, offer opportunities for improved lives and economic progress, and reduce costs and environmental impacts.

This work forms part of the initial foundational research for the Moving Energy Initiative. The overall aim of the project is to increase access to appropriate sustainable energy among displaced people with a view to improving human security, building resilience, and reducing greenhouse gas emissions and deforestation. This will be achieved through practical demonstration of sustainable energy solutions, reform of relevant humanitarian policies and practices, and through enhanced private sector engagement.

Approximately 50% of refugees are in camp settings, with the remainder in non-camp and urban settings. While the trend is towards greater numbers in urban settings, this initial research focuses on camp situations. The report focuses on the benefits and impacts of sustainable energy access for displaced populations. It also considers the challenges to energy access and assesses how the private sector could help to deliver energy for displaced populations. A companion paper, 'Policy and Practice for Energy Provision Among Displaced Populations', focuses on the key actors within the humanitarian system, evaluating existing policies and practices and identifying barriers to increasing provision of sustainable energy solutions within the humanitarian system.

[1] For the purpose of brevity, while recognizing that refugees, asylum seekers and internally displaced persons are distinguishable in law, this paper will refer to them collectively as displaced people or populations.

What is meant by improved access to sustainable energy?

Sustainable energy is about using energy efficiently and using energy generated from sustainable sources and renewable technologies. The energy service must also be sustainable in that the benefits extend into the future. Sustainability also encompasses social, economic and environmental impacts. Thus sustainable energy can improve the health and well-being of women and men, boys and girls, reduce emissions and environmental degradation, and improve energy security. To ensure sustainability, the energy should come from a source that continues to be available and affordable; the service must also be socially and culturally acceptable.

Improved energy access provides a better service to the user. This could be due to a reduction in the negative impacts and coping strategies associated with their current energy use (e.g. reduced hours collecting fuelwood, a reduction in emissions, a reduction in costs) and/or due to an easier experience (e.g. ability to charge mobile phones at home, faster cooking) and a better quality of life, for example through improved lighting levels or better health options. An example of this is demonstrated in the Sustainable Energy for All initiative where as part of the monitoring framework it is proposed that there are different 'levels of energy access'.

Methodology and limitations

The report is based on literature reviews and interviews carried out between July and September 2014 as well as feedback from a workshop held at Chatham House in September 2014. A list of those consulted is included in Annex A. The number of interviewees was limited owing to the holiday period and difficulties in reaching the right people. Case studies for camps in Bangladesh, Kenya and Jordan had also been envisaged, but in each case it was difficult to access the right person or to collect sufficient information.

The paper's focus on some sustainable energy solutions (e.g. improved cookstoves) over others is a direct result of the available literature and does not necessarily reflect the broader approach to energy required to meet the energy demands of camp populations and operations.

Structure of the report

Chapter 2 provides an overview of the current energy needs and energy provision in the baseline situation as well as a summary of the literature on the impacts of this current provision on the environment and on the displaced population and host communities. Chapter 3 is a summary of a literature review of the benefits of delivering sustainable energy solutions to camp populations. It extrapolates from development literature where necessary. At the end of the section the gaps in evidence and literature are identified. Chapter 4 summarizes the potential for sustainable energy technologies among displaced populations and in camp operation and provides an overview of the current engagement of the private sector. It also reviews opportunities for further engagement of the private sector. Finally, Chapter 5 provides an overview of the challenges and risks to sustainable energy provision and proposes some possible conditions that would need to be in place to incentivize the private sector to invest.

Baseline

This section provides an overview of the energy needs and energy supply in camps under the baseline situation. This includes energy for the displaced population as well as energy demand and supply for the camp operators that provide services to the displaced population. The second half of this section gives an overview of the impacts and coping strategies resulting from the current supply and use of energy.

Summary points

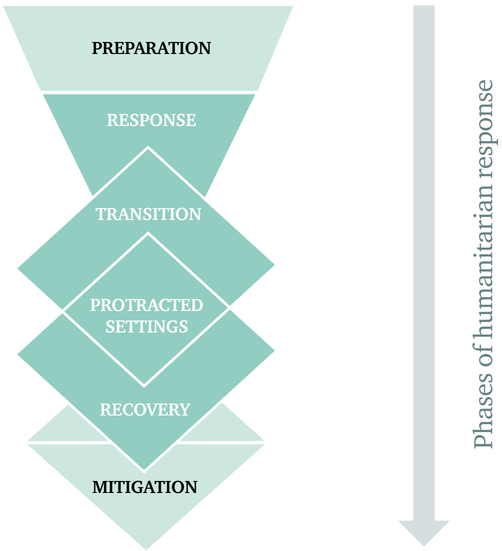
- The basic services required (and associated energy needs) for refugee and IDP camps vary depending on context, cultures and geographies.
- The baseline in most displaced situations is the traditional three-stone fire for cooking and kerosene for lighting. There is a considerable range of literature detailing the negative impacts and coping strategies associated with this baseline. This includes significant impacts on the environment and on residents' well-being. Women and children in particular may be exposed to health and safety risks and have less time for education, livelihoods and social and other activities because of the time they need to spend collecting fuel.
- Energy is also needed to power camps' health centres, schools, water pumping, administration compounds and street lights. Providing this energy costs humanitarian agencies millions of dollars a year, but there is limited literature on the subject.
- It is important to note that in many sites, over many years, there have been numerous initiatives, particularly focused on improved cookstoves or alternative fuels. In addition, solar lanterns are becoming part of standard kits and PV is being used more widely.

The energy needs and basic services required for refugee and IDP camps vary depending on context, cultures and geographies. However, energy is needed at each phase of a humanitarian response. At a minimum, people need energy to cook. Although energy requirements may vary through the different phases, certain basic energy needs must always be met to ensure the nutrition and protection of the displaced people, as well to manage the camp safely and efficiently.

During the response stage of an emergency situation, the affected people need, at a minimum, water, food, shelter and protection. The UNHCR has developed a ranking of the most immediate threats to life in camp situations. At the top of the list is a lack of safe drinking water. Lack of household items and supplies (including fuel), especially for food preparation, ranks eighth (UNHCR 2013a). However, energy would be needed to address many of the other identified threats such as health care and water-pumping.

In later phases, and in protracted settings, camp needs include the construction of more durable shelters and support facilities, installation of piped water supply, improved sanitation, health education campaigns, provision of education and vocational training, agricultural support and income-generating activities.

Figure 1: Phases of humanitarian response



Identification of minimum standards

Aid agencies use the Sphere universal minimum standards and indicators to guide their response and provision of shelter, food aid, health care, water and sanitation. It should be stressed that the standards only guide response and in many cases the Sphere minimum standards are not attained. In most cases, packages of non-food items (NFIs) are provided to displaced populations. Guidelines for items included in the NFI package vary by agency and have changed over time. NFIs include cooking kits (pots and pans), sanitation and clothes, and can in some cases also include energy-related products such as cooking or heating stoves, fuel and lighting. In the latest Sphere edition, items relating to energy are covered under NFI Standard 4: 'Non-food items standard 4: Stoves, fuel and lighting' (Red Cross and Red Crescent (2011)). One of the long-term indicators of the SAFE (Safe Access to Fuel and Energy) Reference Group is that the Sphere minimum standards are met.

Sphere guidelines relating to other services also determine energy demand. With regard to health, for example, Sphere lists several minimum services that require electricity. These include laboratory services (including diagnostic equipment), vaccine and blood storage, as well as the ability to carry out routine surgical and obstetric operations. However, the actual energy needs are not detailed.

Energy demand and supply for displaced population camps

There are a number of ways to describe energy demand and access. Energy demand can be categorized by the energy services needed (e.g. lighting, cooking or heating) as well as by the consumer group. The energy services needed by each consumer group – such as households, small business enterprises and communities – vary widely but include electricity, thermal energy, and liquid and gaseous fuels. The preferences and priorities of different groups and communities are important factors in determining which energy choices are appropriate, especially at the household level. The technical and business energy supply solutions are also likely to vary by consumer group. These distinctions have been used throughout the report.

The baseline described below is a description for camps and other sites where there have been no, or limited, initiatives related to energy. It is, however, important to note that in many sites, over many years, there have been numerous initiatives particularly focused on improved cookstoves or alternative fuels. These initiatives vary in technology and approach and have included provision of kerosene, coal and improved cookstoves, direct and indirect provision of fuelwood (the latter via a voucher) and physical protection of firewood collectors (WCRWC 2006). In addition, solar lanterns are becoming part of standard NFI kits and PV is being used more widely. Aid agencies have begun to recognize sustainable energy. For example, one of UNHCR's objectives for Kenya for 2013 was to ensure that 48% of the population in Dadaab and 50% of the population in Kakuma had access to sustainable energy (UNHCR 2013b). The camp population of Dadaab is currently about 350,000, and approximately 33,000 solar lanterns and 41,000 improved cookstoves will have been distributed by the end of 2014. Thus, 46.6% of the population will have been reached.[2] Worldwide, however, the majority of camp populations' experience is still that described in the baseline. The challenge of addressing all the energy needs for displaced populations is huge.

Refugee/IDP household and productive use

Actual energy use in a household varies depending on the local environment, local availability of energy, local livelihoods, camp organization and local incomes. Since there are so many variables, there are no universally accepted estimates for what an individual or household needs to survive or thrive. Energy needs are instead described in terms of the services that are needed, such as energy for cooking and lighting. Practical Action, in its Poor People's Energy Outlook (PPEO) 2012, proposed a concept of 'Total Energy Access' in which it outlined a range of services believed to be required by a household (Practical Action 2012). This is shown in Table 1. The standards proposed here are provided as an indication of what a household may need and what standards could look like. They are not meant to dictate what is required in a humanitarian setting, where these standards could be considered aspirational.

Table 1: Practical Action's Total Energy Access minimum standards (2012)

Energy service		Minimum standard
Lighting	1.1	300 lumens for a minimum of 4 hours per night at household level
Cooking and water heating	2.1	1 kg woodfuel or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or biofuel per person per day, taking less than 30 minutes per household per day to obtain
	2.2	Minimum efficiency of improved solid fuel stoves to be 40% greater than a three-stone fire in terms of fuel use
	2.3	Annual mean concentrations of particulate matter (PM2.5) $< 10\ \mu g/m^3$ in households, with interim goals of $15\ \mu g/m^3$, $25\ \mu g/m^3$ and $35\ \mu g/m^3$
Space heating	3.1	Minimum daytime indoor air temperature of 18°C
Cooling	4.1	Households can extend life of perishable products by a minimum of 50% over that allowed by ambient storage
	4.2	Maximum apparent indoor air temperature of 30°C
Information and communication	5.1	People can communicate electronic information from their household
	5.2	People can access electronic media relevant to their lives and livelihoods in their household

It is hoped that specific, universally accepted figures may be developed as part of the tracking framework on energy access for the Sustainable Energy for All initiative.

[2] In June 2014 there were an estimated 87,944 households recorded in Dadaab (WFP & UNHCR 2014).

Cooking

For most households cooking is the most important energy need, as 95% of basic staple foods need to be cooked – many for a long time. Where food is distributed for displaced populations it tends to comprise the same basic staple foods, although sometimes biscuits and other food that does not require cooking is also distributed. Most cooked food also requires water, which must be pumped and transported. In many cases water must be boiled before it is safe to drink.

The baseline in most displaced situations is the traditional three-stone or open fire, or other traditional or simple stoves. For example, surveys in South Darfur in Sudan showed that about 90% of the IDPs surveyed use a three-stone fire for most or all of their cooking needs (Galitsky 2005). The fires or simple stoves are used both inside shelters and outside. Traditionally, wood (fuelwood) is used although anything combustible is also used (leaves, bark, grass, paper, plastic, dung, agri-residues, or other materials), particularly when fuelwood is scarce and expensive. In some cases charcoal or coal will be used. One advantage of the fire is that any size of pot can be used for cooking. Most households will have more than one pot and they are likely to vary in size. The unprotected flame and lack of chimney make the fire inherently energy-inefficient. Simple traditional stoves may use less fuel than the open fire but are still generally inefficient. Fires can also produce a lot of smoke, which contributes to poor indoor air quality and related respiratory illness, as well as creating a risk of burns. In addition, open flames create a risk of fire, especially when used in cramped conditions or in flammable shelters.

Quantity: The quantity of fuel used by families depends not only on the fuel and efficiency of the stove but also on fuel availability and cost, the type and method of food cooked, the fuel-tending habits, the pot used, the type of food and the size of the family. Where fuelwood is used on inefficient fires figures measured in baseline assessments and studies vary from about 0.7 kg per person per day up to 3 kg per person per day. Often the fuelwood uses are similar between the displaced population and the host population, although a survey in western Tanzania found that refugees used an average of 2.8 kg of wood per person per day, where local communities used just 1.7 kg per person per day (UNDP 2005).

> Fuelwood use in camps is estimated at between 0.7 kg and 3 kg per person per day. When not provided by camp operators this results in significant quantities to be collected or bought with resulting negative impacts on the families.

Access/provision: Fuelwood is collected from outside the camps or bought. In some cases the camp organizers provide fuel or fuel vouchers. The quantity collected or bought depends on local availability. In North Darfur there is no longer any wood to collect. In the absence of readily available fuel sources, about 90% of families purchase wood, most of which is brought to the region by truck from distances as far away as 160 km. In South Darfur, about 60% of women were purchasing fuel (Galitsky 2005).

Where fuel is provided, the level of provision provided by the agencies depends on the availability of local fuel sources, country policy on fuelwood collection and existing or likely tensions with host communities. Examples include the provision of 9,000 kerosene stoves along with 170,000 litres of kerosene for Somali refugees in Dollo-Ado in Ethiopia (Danish Refugee Council 2011). In Nepal UNHCR started to provide kerosene in 1992 to Bhutanese refugees to reduce tensions between the camp and host communities. At that time it was cheap and easily available. As costs rose, however, UNHCR looked at other alternatives. Unfortunately there was limited willingness among the refugees to switch fuels, partly because kerosene is easy to use and satisfies many of the refugee women's preferences for cooking fuel, and also in large part because they are reliant on the sale of kerosene as a key source of income (WRC 2006b).

Even where fuel is provided it is often not sufficient. For example, in the 1990s, UNHCR supported the Dadaab firewood project but was able to provide only 11% of the required firewood (WRC 2006a). In Farchana camp in Chad it was reported that 7 kg of wood was distributed per person per month, while UNHCR reported that the estimated per capita consumption was 3 kg per day. In an attempt to make fuelwood provision more sustainable, Oxfam distributed fuel vouchers that allowed IDPs to purchase fuelwood in the market. Oxfam then paid the vendors (Kasirye 2009).

Shelter

The provision of shelter is a high priority in the emergency and post-emergency phases and of course essential in countries where there are very low temperatures in winter, such as in Afghanistan. The type of shelter (and the protection it provides) depends on the status of the camp (IDP/refugee), the local climate, the country's regulations (such as policies that ban permanent buildings) and the type and amount of materials that are available locally. In the baseline situation shelters are often basic or makeshift and may not last long; for example, in Dadaab in Kenya they may last only six months in severe weather (Kumassa 2014). The basic structures are tents or transitional structures made of wooden poles, iron sheets and polythene, often made by the refugees/IDPs themselves. These are cold in winter and hot in summer. In the post-emergency phase, other options include more robust structures such as cabins or those made from interlocking stabilized soil blocks (ISSB) technology. Although this technology is not expensive, since it uses locally available material, ISSB shelters have been suspended in Kenya since the government argues that these are permanent structures and so should not be built for refugees, who are only temporary. The aim is to use local material where possible but this can be problematic in areas where there is already environmental degradation. In the baseline situation there is no insulation, or only limited insulation.

In the new Azraq camp in Jordan, insulated T-shelters are provided which are cooler in summer and warmer in winter. An added advantage of these shelters is that they offer greater privacy than other options.

Case study 1: An overview of baseline fuelwood supply and cooking in Kakuma and Dadaab refugee camps, Kenya

Fuelwood is the main source of cooking fuel in Dadaab and Kakuma refugee camps. Fuelwood distribution is carried out monthly by UNHCR and its partners. However, in total the organized firewood supply meets less than 20% of the domestic energy needs of the households; the remaining 80% is harvested from a 25 km radius around both camps, with consequent negative impact on the environment.

Much of the host community relies on the sale of charcoal and firewood to refugees as their main source of income, while the refugees have limited access to host community resources. Consequently some refugees barter food rations in exchange for fuelwood, undermining household food security. The cost of fuelwood depends on its quality. High-quality wood, which is sourced from distant forest locations, costs roughly KES 2,000 per cart, compared to KES 1,500 per cart for lower-quality wood. The security risks inherent in collecting wood contribute to the high prices. Refugee respondents speak of banditry attacks and women collect wood in groups as a precaution against related risks such as GBV.

Over the years a number of interventions have been undertaken at the camps relating to cooking fuel and the environment. These have included provision of sustainably harvested firewood, land rehabilitation, provision of tree seedlings for planting, fabrication and distribution of energy-saving stoves, and monitoring of firewood-harvesting zones. However, these have not been enough as it is not possible for the local environment to meet the high demand for firewood sustainably.

WFP initiated a project on safe access to firewood and alternative energy (SAFE) in 2012. By the end of the SAFE pilot project, 26,000 fuel-efficient stoves had been distributed to 21,000 refugee households and 5,000 host community households in Dadaab and Kakuma. According to informants in both Dadaab and Kakuma who were trained as part of local efforts on how to make stoves, 20% of the participants reported that they were using their own locally made stoves. Problems were reported with the locally produced stoves because they were immovable. In Dadaab, the beneficiaries interviewed by the JAM team expressed some dissatisfaction with the targeting of the stove distribution and a desire for the project to be extended to all refugee households. The refugee respondents pointed out that 'the modality of targeting stoves needed to be better systematized and done through the environment, water, sanitation and fuel committees rather than the elected camp leadership as is the current practice since the latter may be guided by other considerations than need'.

Based on UNHCR-WFP Joint Assessment Mission (JAM) of Kenya Refugee Operation, July 2014.

Heating

In many climates there is a need for heating in winter, and in some cases it can be one of the top preferences of the displaced population. A survey carried out by the Danish Refugee Council (DRC) in Jordan found the top three preferences for assistance during winter were food (30% male respondents, 33% female respondents), cash (28% male respondents, 32% female respondents), and fuel (26% and 28% respectively). The baseline situation depends on the local fuel availability. Either there is no heating, or where heating is provided, it is by cooking stoves, fire or heating stoves fuelled by coal, charcoal or fuelwood. Heating stoves and fuel are sometimes provided as part of the NFI winterization kit. In Pakistan, for example, the International Organization for Migration (IOM) provides improved stoves along with blankets, floor coverings, and clothes. In previous emergencies in Pakistan, fire outbreaks in tents and temporary settlements have led to the banning of stove distribution. Now any distribution must be accompanied by fire safety public information and preparedness (IOM 2013). CARE International has supplied butane stoves in Lebanon, and in Syria IOM has distributed 150 stoves along with 60 tonnes of coal to combat the cold winter. Oxfam have provided gas heaters along with refill for four months to refugees living in flats. In Lebanon, in addition to winter kits, cash assistance or winter vouchers are distributed; these are intended to help with the purchase of stoves and monthly fuel (Oxfam 2013b, Save the Children 2013a). ACTED is also distributing hygiene kits, baby kits and cash assistance for stoves and fuel, in the region.

Lighting

Homes need lighting to manage after dark. According to Sphere's standard 4, which covers NFIs, 'Each household also has access to appropriate means of providing sustainable artificial lighting to ensure personal safety' (Red Cross and Red Crescent (2011)). Lighting in the baseline situation is provided by kerosene lanterns and candles or from the light of the fire. Although the level of lighting given by candles and lanterns meets the Sphere standard, it is not sufficient for children to study after dark.

Such low lighting levels also make it difficult to carry out household chores, limit any additional income- generation activities after dark, and provide little protection. Burning kerosene also contributes to household air pollution and black carbon emissions, and there is a fire risk associated with candles and kerosene. In some situations aid organizations provide the kerosene; in others, household members must purchase it, which has obvious impacts on their limited incomes.

Electricity is not usually available to the displaced population. According to UNHCR, 72 refugee camps in Africa do not have electricity (UNHCR 2012). More and more frequently, however, portable solar lanterns are being provided as part of the NFI kits. As the Sphere Handbook states,

> Lanterns or candles can provide familiar and readily sourced lighting, although the fire risk of using such items should be assessed. Provide other types of artificial lighting to contribute to personal safety in and around settlements where general illumination is not available. The use of energy-efficient artificial lighting should be considered, such as light-emitting diodes (LEDs), and the provision of solar panels to generate localized electrical energy (Red Cross and Red Crescent (2011)).

Examples are widespread and include the distribution of solar lanterns in Somalia by the DRC and the Norwegian Refugee Council (NRC), and the use of solar lamps in Myanmar and Kenya, where they have been funded by IKEA, the European Commission's Humanitarian Aid and Civil Protection department (ECHO), Panasonic, the Canadian International Development Agency (CIDA), UNHCR and Waka Waka. In 2012 in Thailand the Koung Jor Shan refugee camp claimed to be the world's first solar-powered refugee camp. Each household had been provided with solar panels to replace its kerosene lamps and candles (Earth Day Network 2013).

Communication

IDPs and refugees are increasingly owners of mobile phones. Phones are important not only for keeping in touch, day-to-day communication and finding missing family or friends,[3] but also to find out about the situation elsewhere, which affects decisions on staying or going back home. A survey carried out in the Ugandan camps found that 70% of rural refugees regularly use mobile phones to communicate, even with limited internet access (Betts 2014). Mobile phones can also be used to access health information, establish businesses, for payments (such as M-Pesa) and for collecting data. Ugandan telecoms companies are even targeting Ugandan refugee camps to access the money transfer service market in the settlements (Omata 2013). WFP is looking at mobile technology as a more efficient way to collect data to inform its decisions. For example, in a project in refugee camps in eastern Democratic Republic of the Congo, the WFP gave out 300 basic phones and used a WFP-based the live call centre to conduct surveys assessing what people were eating, how much and how often. After six rounds of surveys, 72% of the original survey group still answered calls, indicating that the phones were seen as a valuable asset for families (Hoffman 2014).

Radios also provide valuable – and potentially life-saving – information, for example in critical areas with no communication and electricity following a natural disaster. Mobile phones can be used as radios, lights and for playing music. The private sector has recognized this need and the baseline for charging phones is to pay for a charge from a local entrepreneur with a car battery or his/her own generator or PV panel. In Haiti, for example, Digicel installed solar street lighting with mobile phone chargers. Not only did this provide a service to the IDPs but it also helped the relief organizations to

[3] For example, Refugees United is a family reconnection platform operating in the Middle East and in East Africa which uses a mobile application. Some 280,000 refugees have registered on the service.

communicate with the IDPs. Radios use batteries. Many of the solar lights that have been provided include mobile charging points; in some emergencies, solar radios have been handed out to help keep the population informed.

Other electricity-based services

Household electricity needs are modest, yet if household incomes increase there is demand and opportunity for further appliances such as fans, TVs, computers, irons and refrigerators. In most refugee/IDP settings the demand for these services is not met, although there are exceptions where site-wide electricity is available and electricity is bought or stolen. For example, in the new Turkish-funded Kilis camp for Syrian refugees, the housing containers include refrigerators and TVs (Mclelland 2014). In the Zaatari camp in Jordan it was reported that 75% of the households were connected to electricity just 18 months after the opening of the camp (ACTED 2014a).

Productive uses

There is a well-established link between energy and economic growth (Ozturk 2010) (Practical Action 2012) (UNDP 2012). As in any town, small businesses are a major source of income and employment in camps. Typical small businesses employing refugees and IDPs in and outside the camp include restaurants, shops selling chilled foodstuffs, mobile phone and car battery charging services, sewing shops, artisan workshops (eg. metalwork, pottery, woodwork), brick- and charcoal-making enterprises, electrical shops and vehicle repair services (including the use of welding and compressors), internet providers, computer game arcades, and television/DVD cinemas. Women play a key role in small businesses in camps but their role is often overlooked as it involves unpaid or informal sector activities.

Energy is essential for service and production businesses in both the formal and informal sectors. A literature review on the linkages between modern energy and micro-enterprises carried out in 2003 found that modern energy can help facilitate the development of micro-enterprises, but alone does not automatically result in enterprise development. Instead energy access is one of a number of critical enabling factors needed for enterprise development (Meadows 2002). Many camp businesses need electricity to operate and others such as traditional brick making and, to a lesser extent, lime kilns, bakeries and restaurants need fuelwood or charcoal. As an example, according to the University of Zalengei's Forestry Department, a typical 100,000-brick kiln in Darfur will need about 35 trees for firing (Tearfund 2007). Lighting enables increased operating hours for entrepreneurs, shops and workshops, while street lighting helps to extend opening hours for market vendors. Quality light in the home can also enable productive activities after dark. This can have a marked impact on women, as more women work in home-based enterprises and in businesses related to traditional female roles – e.g. cooking, hairdressing, clothes washing and sewing.

In most camps there is no site-wide electricity infrastructure and fuelwood is expensive or time-consuming to collect, so the potential for these industries and income generation generally is very limited. Small operations are run on private, small, inefficient diesel generators with the associated high costs, local noise and pollution. In other cases an informal electricity economy has been created that taps into existing electricity infrastructure for street lighting. This has contributed to bills to UNHCR as high as US$500,000 month at the Zaatari camp (Williams 2014). Lighting is provided by kerosene lamps, candles and increasingly by solar lanterns. Cooking is carried out on inefficient stoves and ovens.

Camp infrastructure and management

Energy provision facilitates infrastructure services and services for health and education, as well as for community and camp administration.

Health, education, community centres and police stations

Electricity is needed to provide the level of health services required in a camp. Sphere guidelines include the provision of health posts, health centres, pharmacies and a field hospital, depending on the likely size of the camp. The electricity-dependent services classified by Sphere as a minimum standard include laboratory services (including diagnostic equipment), vaccine and blood storage, and the ability to carry out routine surgical and obstetric operations. In addition, a small clinic needs basic lighting and equipment sterilization, while larger facilities need greater levels of power for medical equipment and instruments. Improved lighting allows patients to be treated and emergency operations to be held after dark. Well-equipped maternity facilities and improved water hygiene improve maternal and infant health care. There are many women of child-bearing age in camps. Where services are limited, owing to electricity limitations as well as a lack of qualified staff and equipment, it can be difficult to carry out caesarean sections and complicated deliveries. In many instances, these cases must go by ambulance to another hospital.

Lighting around clinics and hospitals increases public safety and acceptability of services, as does the provision of air conditioning and heating. Greater uptake of health services means an increased number of patients are provided with treatment and preventive services, which leads to improved health and better patient recovery. Air conditioning is not commonplace in hospitals or clinics.

Electricity is also needed for Information and Communication Technology (ICT) including access to databases for information and the internet to include immediate reporting of epidemiological information, as needed in an emergency situation. In addition, electricity for doctors' and nurses' accommodation is needed. In some cases the health centres must also provide meals for the patients.

Once camps are established schools are needed to provide education to the camp's children. In most cases schools provide meals for pupils, so one of the biggest demands for energy is cooking fuel. In addition to cooking (and heating if needed), energy demands may include electricity provision. Lighting can enable evening classes to take place, whether for additional children's classes or for adult education and literacy classes. The provision of modern learning technologies including computers and the internet enables access to educational material, distance learning and continuing education for teachers.

Community centres and religious centres (mosques, churches) can also extend their hours and provide more services where electricity is available, in particular for lighting, but also for ICT, communication and entertainment (TV, DVD, speakers).

Security, lighting, communication, water pumping and waste management

Energy is necessary for water pumping and street lighting. The energy requirement for the former depends on the local availability of water, the depth of bore holes, and the quantity of water supplied (at least 20 litres per day per person), among other variables. Street lighting is included as one of the Sphere minimum standards to promote safety and security. In particular, lighting is needed around WASH facilities to improve security; it can enable market activity after dark. Sphere includes the provision of a public address system in its standards, which also requires electricity.

Administration and logistics

Energy is needed for the administration of the camp and for its staff. This includes energy for a reception centre (including meal provision for new arrivals), office blocks, residential units, kitchen and cafeteria units, laundry services, water pumping and security. The majority of the services required (lighting, air conditioning, ICT) need electricity, while other services need thermal power (cooking, water heating).

Baseline energy provision for camp operation

The baseline for electricity supply in camps is to provide these services either from banks of centralized diesel generators or from stand-alone generators; in other cases, the camps simply go without energy service provision or power. Where centralized, the service is supplied 24 hours a day. Diesel generators have several advantages: there is a low initial investment, they are easy to install and can be mobilized quickly, and they are mobile and modular, providing the flexibility required. They are also easily understood and many people already possess the skills to repair them. However, the engines are frequently over-sized and maintenance is expensive. If spare parts are not available, or the problem is not identified quickly, then, according to UNEP, their engines can be out of use for anything between one week and one year.

Air conditioning is provided through box air conditioners, which are powered by electricity. Water heating is provided through thermal boilers as well as electricity heaters. The fuel of choice for cooking in the staff cafeteria is liquefied petroleum gas (LPG) but in some cases this is considered a security risk and electric cookers are used. There is no energy management, no energy metering and in many cases energy costs are paid on a metre-squared basis, which includes all of the above services but provides no incentives for energy saving.

The baseline for institutional cooking is the use of large pots on open fires or inefficient stoves, mainly using fuelwood. Schools' feeding programmes typically provide cooked meals for hundreds of children, making them among the largest institutional users of firewood. WFP Kenya found that some schools charged two shillings a day if a child did not bring firewood for the lunch meal.

The use of renewable energy, and solar power in particular, is increasing. For example, in Dadaab, solar panels are installed on many schools, dispensaries, mosques and shops. This provides mobile phone charging services that are solar-powered, as well as those that are run through privately powered generators (Danish Refugee Council 2010). UNHCR has installed PV pumping on two boreholes in Dadaab and put in solar panels to power radio communication and internet connectivity as a back-up to the diesel gensets in the UNHCR office. Other UNHCR initiatives include solar-powered lighting systems along the perimeter fence at Hagadera Hospital; solar-powered office lighting and machines at two field offices; and solar-powered water chlorination dosers and pumps in the UNHCR compound (UNHCR 2014b).

Solar water heating is widespread in Palestine and UNRWA is installing solar water-heating systems in at least five of its 24 health centres in Jordan, as well as solar power in schools, health centres and area offices (UNRWA 2013). Zaatari Fcamp has solar LED street lights as well as centrally powered ones. UNHCR states that it uses three types of solar street lights, which it selected on the basis of local needs. The agency claims that these are energy-efficient and have added theft protection (UNHCR 2012). The newly completed Azraq camp in Lebanon has solar street lights and solar-powered air conditioners in the community centre. NRC installed 30 solar lighting posts in a settlement in Puntland. Solar street lighting has also been installed in Haiti. WHO regularly provides solar-powered vaccine refrigerators and WFP has developed an autonomous system to provide security, operational voice and data connectivity, which includes the satellite and radio networks as well as power from solar panels and generators.

Impacts of current energy supply

Evidence of the impact of the current energy supply on the local environment, on time and income, on host community relations and on security and gender-based violence is provided in socio-economic and environmental impact studies and assessments in IDP and refugee camps and in their surrounding areas. These studies use interviews, focus group discussions, surveys and mapping to assess these impacts.

Environment

The environmental impact of refugee or IDP camps varies according to the location, the local environment and the type of camp (whether IDP or refugee) (Hagenlocher 2012). IDP camps often have fewer relief resources available, so residents are more dependent on locally available resources. Nor surprisingly, studies concentrate on camps that are established in already environmentally sensitive areas such as dry-lands or areas adjacent to a national park. In the Democratic Republic of the Congo, for example, Mercy Corps noted that there were more than 850,000 displaced people living in 13 IDP camps all on the border of the Virunga National Park, a World Heritage Site (Mercy Corps 2008). The park was already under severe pressure from local population growth prior to the IDPs' arrival. Severe deforestation due to firewood shortages in dry-land camp areas, desertification, land degradation, unsustainable groundwater extraction and groundwater pollution have all been observed in the areas surrounding many of these camps, i.e. within a radius of up to 15 km (Tearfund 2007). Firewood collection for the camps as well as for the host populations is one of many contributing factors to this environmental impact. Other factors include the use of wood for construction or productive activities (e.g. brick making and charcoal production), the expansion of small-scale farming, livestock grazing and water abstraction.

Firewood is often the most significant resource harvested around camps; this has clear impacts on the local biomass resources. A household survey carried out at Dadaab found that average energy consumption dropped from 1.5 kg per person per day in 1998 to 1 kg in 2010, indicating an increasing shortage and commercialization of the supply chain. The survey also stated that by 2010 personal collection of firewood by refugees had almost ceased and fuel supply had become a major commercial enterprise. Groups of 15 (for protection) travelled between 30 km and 50 km with donkey carts to collect firewood, spending two to three nights out on each trip. With the commercialization, harvesting has become more selective for high-value wood species. The results of their quantitative survey suggest that the firewood supply business is dominated by camp residents and that their access to the wood is still accepted by host populations (Danish Refugee Council 2010).

> Tanzania saw permanent deforestation in the late 1990s as a result of the arrival of refugees, who used an estimated 1,200 tonnes of firewood a day (UNHCR 2002b). Around Dadaab in Kenya wood collection has increased the distance from which the firewood is gathered over a 20-year period from 5 km up to 70 km. The rate of resource depletion has been found to be directly proportional to the radial distance from the camps.
>
> **GIZ 2011**

Another knock-on effect is that the greater the harvesting distance the higher the price. Thus, resource depletion increases the number of camp residents who can no longer afford firewood.

Protection and security

A study carried out in 2009 reviewed data from UNHCR's Annual Protection Reports and concluded that five main challenges resulted from issues of household energy (specifically fuelwood collection). These included increased vulnerability to the risk of sexual and gender-based violence (SGBV); an increased danger of arrest and refoulement; and the risk of jeopardizing both the voluntary nature of return and the willingness of authorities to grant asylum to refugees (Lyytinen 2009). In addition women have cited physical injuries such as snake bites, animal attacks and even landmines in some locations.

There is significant literature which cites occurrences of SBGV during firewood collection trips. These vary across camp surveys and are supported by anecdotal evidence. Some reports provide quantitative data, but owing to the stigma in reporting rape such data can be difficult to collect. As a result of these reports many past and on-going energy initiatives cite improving protection as their key rationale.

Examples of incidences of SBGV include:

- A report carried out by Save the Children in the Dadaab refugee camps on the Somalia–Kenya border found that young girls and adolescents in particular are frequently attacked while searching for firewood, going to the toilet or walking to collect water, all of which entail walking to the outskirts of the camp or farther, which exposes them to increased risk (Save the Children 2013b).
- The Women's Refugee Commission report *Finding Trees in the Desert* states that women must typically walk 5–10 km to find fuelwood and cites a figure of more than 200 cases of rape in Darfur each month (WRC 2006a).
- In Doro camp, South Sudan, women in 11 out of 16 focus groups reported being physically and sexually assaulted when going to the forest to collect firewood. Incidents include beating, sexual abuse and attempted rape. The same study found that physical and sexual assault also takes place at water points. More than half (52%) of 131 respondents reported incidents of violence against women at water points (Danish Refugee Council 2012).
- In 2009 Mercy Corps conducted a survey of displaced households in DRC and found that 90% of the people surveyed reported that they had experienced some form of harassment, violence or rape while collecting fuelwood in the forests (Mercy Corps 2010b).
- A 2007 article refers to attacks and implies that they are related to fuelwood collection: 'In August 2006 the International Rescue Committee (IRC) reported 200 assaults in a five-week period from a single camp. Médecins sans Frontières reported over 200 cases per month in 2005.' This is likely to be under-reported (Patrick 2007).
- UNHCR reported a total of 52 rapes (26 adults and 26 minors) from its survey in the 12 refugee camps in Eastern Chad and noted that it was almost certainly an under-reporting (UNHCR 2007).
- A study undertaken by Physicians for Human Rights, also in Chad, in the Farchana refugee camp, found that a total of 20 rapes were perpetrated against 17 of the 88 women interviewed, plus an additional 12 instances were considered highly probably (both in Chad and in Darfur). The majority of the confirmed rapes occurred outside camps while women were collecting firewood or grazing animals (Physicians for Human Rights 2009).

As outlined above, another protection challenge relates to the increased risk of arrest for illegal fuelwood collection. In Lyytinen's report of challenges she found a number of incidences in the UNHCR's protection reports. These included the following:

- In Bangladesh, some refugees were arrested in 2007 for firewood collection despite UNHCR efforts to reduce the need for this activity. Although UNHCR has distributed compressed rice husk as an alternative fuel, some refugees sell their allocation and continue to collect firewood.
- In Djibouti, the authorities have also threatened to detain those who are caught collecting firewood in the forests.
- In the case of Ethiopia, refugees are officially forbidden to leave the camp to collect firewood. However, this regulation has been widely ignored as a consequence of inconsistencies in kerosene distribution (Lyytinen 2009).

Security issues (as well as privacy issues) are frequently cited as barriers to the use of the communal WASH facilities. Security issues have been found to be heightened by the distance to facilities and the lack of lighting. One of the reasons for women's fear of using communal kitchens is a lack of lighting inside and around the kitchens. Other reasons included men hanging out nearby, poor hygiene and fear based on rumours. The participants in focus group discussions mentioned only one specific attempt of physical violence, although this could have been under-reported owing to the stigma and shame (Serrato 2014).

> In a recent perceptions study carried out at the Zaatari camp in Jordan, although 80% of respondents felt safe, women in the camp identified latrine/shower blocks and communal kitchens as the most insecure locations. Nearly one-quarter (24%) of participants said that safety concerns stopped them using communal kitchens.
>
> **Serrato 2014**

In South Sudan, where many displaced people are still living in open areas, protection monitoring revealed that vulnerable groups felt unsafe at night because of a lack of lighting, in particular when going to latrines, collecting water or using bathing areas (ACTED 2014b). IOM carried out two rapid assessment surveys and found that GBV prevalence was very high in two IDP settlements in Somalia. Many of the incidents took place at night, when the settlements were plunged into darkness.

Socio-economic issues

The literature describes clear impacts from current energy delivery in terms of health, education, economic circumstances and livelihoods.

Health: There is a mass of evidence relating to the negative impacts of breathing in the smoke from cooking over open fires and inefficient cookstoves (WHO 2014). In addition, the fumes from kerosene lanterns result in negative health outcomes. Worldwide, about 4.3 million premature deaths a year are from illness attributable to the household air pollution caused by the inefficient use of solid fuels. There is also evidence of links between household air pollution and low birth weight, tuberculosis, cataracts, nasopharyngeal and laryngeal cancers (WHO). This equally affects refugees and IDPs who are cooking in temporary shelters and crowded conditions. Only one specific study relating to camps found that levels of particulate matter and carbon monoxide were significantly above the WHO guidelines (Pennise 2009), but the development literature can be extrapolated to camp conditions.

Safety: There are also examples of fires in camps caused by open fires, kerosene lamps and candles.

> A cooking accident triggered a fire in Ban Mae Surin refugee camp in Thailand in 2013, killing 37 refugees, leaving 2,300 homeless, and destroying a clinic and food centre. A fire caused by an oil lamp destroyed 95% of the structures in the Goldhap refugee camp in eastern Nepal in 2008.
>
> **UNHCR 2008**

Education can suffer because a lack of good-quality light in households makes it difficult for students to study after dark. In cases where children are asked to contribute to the fuelwood for the school stoves, they may not attend owing to lack of fuel. Where incomes are low and school fees are needed, some families may keep their children from school to save the income for fuel.

Time impacts: As stated earlier, many women need to spend hours collecting fuelwood or must purchase fuel from their limited incomes.

> In Ethiopian refugee camps women must leave the camp several times per week to gather fuelwood for cooking; such trips last up to eight hours (Rogers 2013). In a recent assessment of refugee camps in South Sudan, women were found to spend between six and 25 hours a week collecting fuelwood.
>
> **ACTED 2013**

Economic impacts: In Darfur IDPs who buy fuelwood were estimated to spend about 200 SDD (roughly US$0.90 in November 2005) on it each day. This cost is likely to have increased as fuelwood supplies have been depleted. As noted earlier, about 60% of women in South Darfur and about 90% of women in North Darfur camps purchase fuelwood. In addition to cooking there is also a need to purchase fuel for lighting and to charge mobile phones. Outside camps in East Africa, the estimate for kerosene for one lamp and mobile charging is about US$0.2 per day for each.

Negative coping strategies: Nearly every study on refugee livelihoods has observed negative coping strategies, which become more frequent when few other options are available (UNHCR 2006). Such strategies include selling food rations to buy fuel and/or missing meals because of the lack of fuel, both of which result in poor nutrition levels. Surveys in Darfur found that selling some of the food rations to purchase fuel to cook was significant at 40% in South Darfur and even as common as 80% in North Darfur. The same survey found that significant numbers of families (50% in South Darfur camps, and 90% in the North Darfur camps) were missing meals owing to the lack of fuel (Galitsky 2005). Another study on livelihoods in Dadaab found that food rations were often sold to fund the purchase of more desirable food items and also firewood (Fox 2013).

Other negative coping and livelihood strategies range from (illegal) collection of natural resources such as firewood for use and sale. An overview of in-camp businesses carried out in Dadaab showed that firewood sales were a key business, particularly for the poor (Fox 2013). A study of enterprises in Sudan showed that livelihood strategies included collecting firewood, charcoal and grass (Abdelnour 2008). A review of refugee livelihoods also showed that as part of their livelihood strategy, refugees engaged in petty trading, such as providing services or buying and selling goods, including energy commodities (firewood, charcoal, vegetables, prepared food, cigarettes, sweets, etc.) UNHCR 2006).

Tensions with host community

Another impact of natural resource use and a decreasing wood supply around camps is growing tensions between refugees/IDPs and local populations. Collection of firewood has caused tensions and conflict between host communities and refugee and IDP populations. As an example, such tensions even led to a court injunction in Kenya barring UNHCR and NGOs operating in Dadaab from collecting fuelwood from the Garissa district (Human Rights Watch 2002). Similarly the Kakuma camp has a policy of discouraging refugees from using the limited natural resources. In a recent survey in northeastern Kenya, the host community complained about the tree felling for shelter and firewood, saying that it was exacerbating environmental degradation (Kumassa 2014).

Tensions also result over access to land for grazing, insufficient water and jobs plus resentment of support and services provided to the refugees. Findings from focus group discussions conducted by Oxfam with both refugee and host communities in the Upper Nile region of Sudan found that tensions between the groups had arisen for a number of reasons including the cutting and selling of wood, access to employment, and access to land for cultivating and grazing (Oxfam 2013).

Economic

The literature on camp energy, and its impact, focuses on energy for the residents rather than on the camp operation. Clearly, however, operating diesel generators 24 hours a day adds an enormous cost to camp operation for the agencies. It also exposes the implementing agencies to world fuel price fluctuations and additional risks in transporting large volumes of fuel in regions with poor security.

> In Dadaab, water pumping alone is estimated to cost US$1.3 million a year
> **Calculated from data provided in email communication with Ernest Achtell, DFID Kenya, September 2014**

Unfortunately it has not been possible to get a clear idea of these costs but based on the camp's high energy needs, it must be in the millions of dollars. Further research at specific camps is required to get a clear idea of the costs of diesel-based power generation. For comparison, the UN Environment Programme (UNEP) has estimated that about 10% of the peacekeeping budget is spent on fuel, equal to more than US$700 million per year. According to UNEP, simply changing behaviour and introducing low-cost measures could lead to savings of 30–40%.

Evidence of Benefits of Sustainable Energy for Displaced Populations

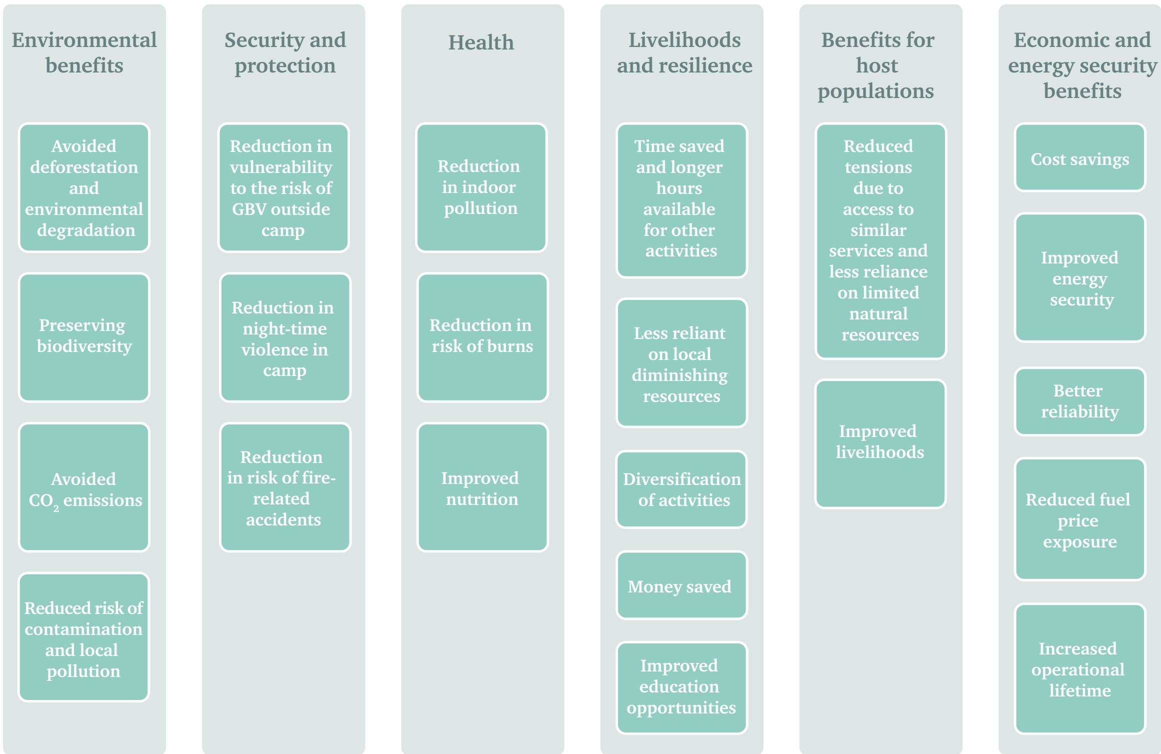
This section reviews the evidence relating to the benefits cited as a result of the provision of sustainable energy for displaced populations.

Summary points

- The benefits of sustainable energy for displaced populations can be divided into six main categories: security and protection, health, livelihoods and resilience, environmental benefits, benefits for host populations, and economic and energy security benefits.
- The literature review shows that there are few studies that have independently assessed the impacts of sustainable energy actions in refugee or IDP camps. This lack of literature on the benefits of alternatives is in stark comparison to the range of literature available on the issues relating to the baseline provision of energy.
- There is evidence of these impacts but it is patchy, not systematic and often anecdotal. The clearest evidence is that in most cases there is a real reduction in fuelwood use following the introduction of improved cook stoves (ICS) or alternative energy stoves.
- Monitoring mechanisms for sustainable energy projects in camps are often limited to the number of items distributed (or proxies are used) and do not provide a direct indicator of the impact or outcome of the energy interventions. Changes to the local environment or to the occurrences of GBV outside camps have not been monitored directly. Similarly economic opportunities as a result of an energy programme have not been reported. No studies have monitored the change in outcomes due to solar lighting projects; similarly, none have tracked the the use of sustainable energy in camp infrastructure and management.
- More robust research is needed to investigate the links between sustainable energy interventions and their expected outcomes and impacts.

The benefits of sustainable energy for displaced populations have been widely cited and are often used as the rationale for funding and initiatives in the sector. These benefits fall into six main categories, as shown in Figure 2.

Figure 2: Benefits cited from access to sustainable energy

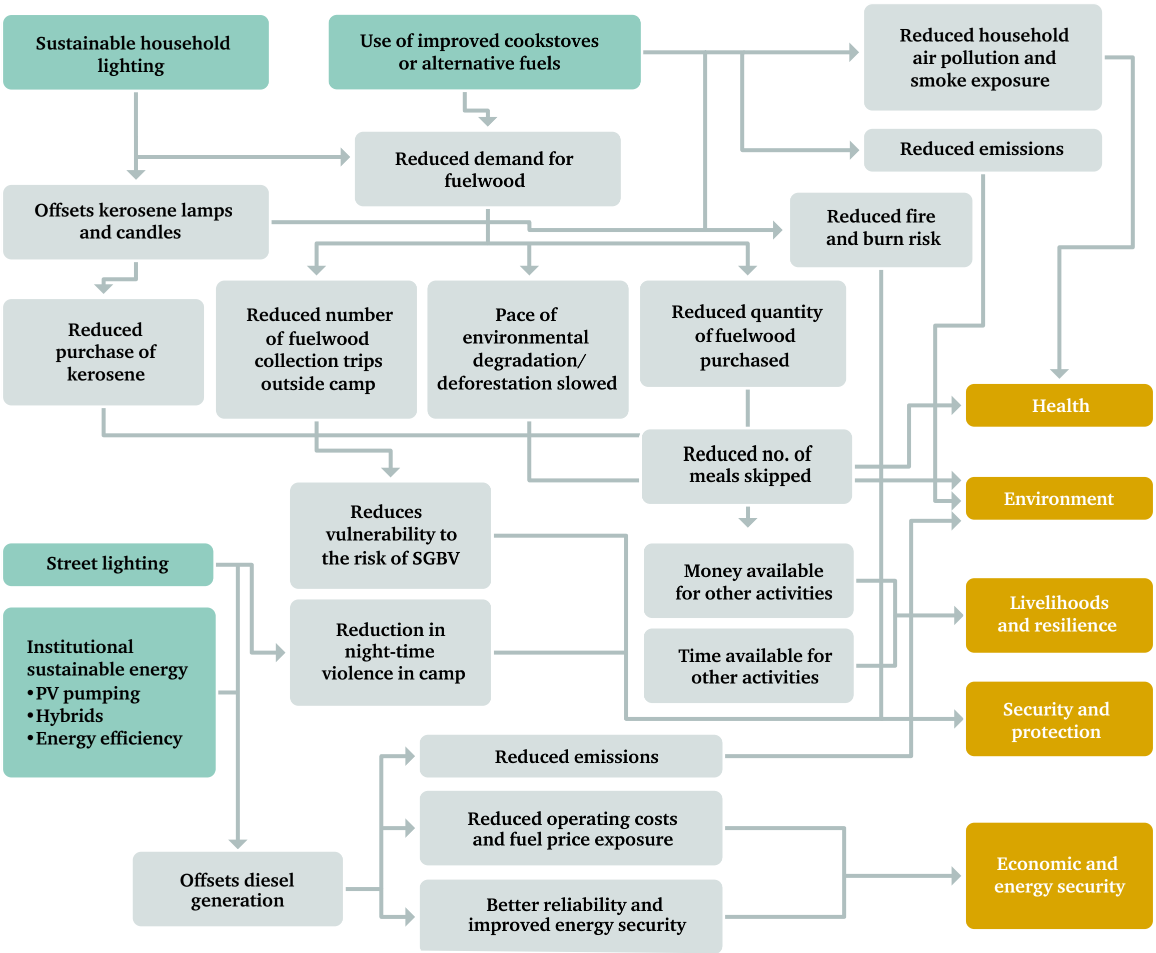


A literature review was undertaken to identify evidence of these benefits from the supply of sustainable energy solutions for displaced populations. At the same time, evidence was sought on the impacts of sustainable energy provision among displaced populations for the local host population. Specifically, answers were sought to the following questions:

- How can access to clean energy among displaced populations contribute to positive environmental outcomes?
- What are the health and social benefits of increased clean energy access among displaced populations?
- Does clean and appropriate energy support displaced men and women to create secure livelihoods and develop economic enterprise?
- What are the potential benefits of energy provision among displaced populations for surrounding host communities?

The theory of change underpinning these questions is that access to clean and appropriate energy for displaced populations can lead to improved health and social benefits, such as improved security and reduced vulnerability to the risk of gender-based violence, as well as reduced emissions and environmental impacts. The use of renewable energy and energy efficiency measures for camp operations will offset fuel use, thus reducing costs for humanitarian agencies, limiting their exposure to fluctuating fuel prices, and reducing their emissions and environmental impact. The chain of assumptions behind this is relatively straightforward and is shown in Figure 3 and the following list.

Figure 3: Theory of change for benefits from sustainable energy in humanitarian settings



Improved/alternative energy stoves

- Use of improved cookstoves and alternative fuels results in less fuelwood being used.
- Reduced demand for fuelwood may reduce the number of fuelwood collection trips outside the camp or reduce the quantity of fuel purchased.
- Fewer collection trips reduces vulnerability to the risk of sexual and gender-based violence.
- Less fuelwood collection slows down environmental degradation and deforestation.
- Reduced fuelwood collection can also ease tension over the use of and access to fuelwood.
- Use of improved cookstoves and alternative fuels may create new income-generating opportunities through camp residents having more time and money available.
- Reduced quantity of fuel burnt results in lower emissions levels.
- If used correctly, new stoves reduce exposure to smoke.
- Reduced household air pollution results in lower rates of respiratory-related health problems.
- Protected flames in new stoves lead to fewer burns and household fires.
- Less fuelwood needed per meal reduces the number of meals skipped or undercooking of food and reduces the need to sell food to buy fuelwood.

Sustainable lighting and mobile phone charging

- Use of household electric or solar lights reduces the need for kerosene lamps and candles.
- Reduced use of kerosene lamps and candles reduces the risk of fires and burns.
- Reduced use of kerosene lamps reduces carbon dioxide emissions.
- Reduced purchases of kerosene and candles creates economic benefits.
- Reduced cost of mobile phone charging creates economic benefits.
- Better-quality light available for longer hours enables income-generation activities.
- Better-quality night-time light allows children to study.

Renewable energy and energy efficiency

- Use of renewable energy and energy efficiency offsets diesel-based power generation.
- Reduced diesel consumption leads to reduced carbon emissions.
- Reduced operation of generators leads to noise reduction.
- Use of renewable energy and energy efficiency reduces camp operating costs.

The literature review covered secondary data from academic and development reports and project and programme evaluations as well as agency websites to try to establish the evidence for these benefits. The methodology for the literature review and the search term is included in Annex A.

The literature review revealed that few studies have independently assessed the impacts of sustainable energy actions in refugee or IDP camps. This lack of literature on the benefits of alternatives is in stark comparison to the range of literature available on the issues relating to the baseline provision of energy. Although the number of energy-related activities has increased significantly in recent years, there appears to have been limited monitoring of their impacts. There is, however, a larger literature on the benefits of sustainable energy access in non-refugee/IDP situations, from which some hypotheses might be generated. For example, it seems likely that sustainable energy supply can improve the economic and social well-being of camp residents and reduce the environmental impact of the camps.

Quite a few studies have assessed the impact of improved cookstoves but in most cases these have been carried out by the project promoter and only positive results have been shared. The majority of this evidence on improved cookstoves relates to fuelwood use, although there is some evidence on the impacts on protection and indoor air pollution. There is very limited reference to the impacts of other alternative energy and renewable energy in camp situations. In most cases results are anecdotal; moreover, proxies are often used in place of direct indicators of the impact of the energy interventions. Owing to the lack of literature related to non-cookstove interventions, the literature review has a strong bias towards reported results from improved cookstoves.

Environment and natural resources impacts

Environmental benefits are likely to result from any sustainable energy initiative that has been well thought through. However, there is always the possibility of unintended negative environmental consequences. For example, easier cooking and more available income could result in more food being cooked, which could lead to greater fuel consumption, even if the stove being used is more efficient.

The review found reports and papers primarily related to stoves. There was some limited discussion of solar lighting, but almost none on the use of renewables for mini-grids, institutional or infrastructure energy services. The environmental benefits – for example, a slowdown in environmental degradation and deforestation – have not been measured, but in many of the studies such benefits are assumed. Instead a reduction in fuelwood consumption is used as proxy for positive environmental impacts. It should be noted that many stove initiatives are implemented in tandem with tree planting, nurseries or other direct forestry activities; however, the benefits of these have not been included in the literature review. Other environmental advantages cited in the literature include a reduction in carbon dioxide emissions, which has been calculated on the basis of the fuel consumption reduction.

Households – cooking

The literature includes many examples of programmes to introduce improved cookstoves or alternative energy stoves. The most frequently cited advantage of such initiatives is the reduction in fuelwood use. That said, most stove programmes have not been monitored for impacts (other than distribution figures), or if they have, the information is not publicly available. The Global Alliance for Clean Cookstoves (GACC) and the Women's Refugee Commission (WRC), on behalf of the SAFE Reference Group, carried out a mapping exercise of improved cookstove initiatives in refugee and IDP settings. The two groups mapped just fewer than 100 programmes, all of which were implemented by their partner organizations; these included the distribution of cooking stoves, construction of stoves and fuel distribution. More than half of these programmes do not have monitoring data.

In the studies available, fuelwood reduction is sometimes measured on the basis of household interviews and focus group discussions, sometimes extrapolated from controlled cooking test results, and sometimes calculated according to the theoretical savings of the stove based on lab testing. The most reliable figures are those gained from monitoring data since the cooking methods, fire management, type of wood used (size, humidity, etc.), and number of stoves used will all affect the likelihood of reaching the gains estimated from lab testing results. Figures reported range from no reductions to as high as 100% when alternative fuels are used. However, the clear majority of the reports do claim considerable savings.

There are a number of reasons why there may be no reductions in fuelwood, or even an increase in demand, following the introduction of improved cookstoves or alternative energy stoves. These include projects where the stoves were not appropriate and therefore not widely accepted and used; where there was not a quality control system for production; where the stoves were not being used correctly for lack of training; or where a greater amount of food was being cooked following the introduction of the new stove. Two studies carried out by USAID on ICS programmes in Darfur and Northern Uganda concluded the fuel-saving claims made by the implementers could not be verified and that several stoves performed only slightly better or worse than a three-stone fire, for some of the above reasons (USAID 2007) (USAID 2008).

> The results of most ICS evaluations or assessment reports show significant fuelwood savings; normally between 30% and 70%.
>
> **See, for example, Amrose et al. (2008), Hood (2007) and Mercy Corps (2008) (2010a)**

The results of most evaluations or assessment reports do report significant fuelwood savings, normally between 30% and 70% for ICS. Many of the stove programmes have been concentrated in camps in Sudan, Kenya, Uganda and Ethiopia, so reports are focused on those countries. Of course the savings depend on so many factors that what is achievable in one place is not necessarily achievable elsewhere. Examples of savings reported include the following:

- A study carried out by GIZ following the production and distribution of Maendeleo Portable Stoves to cover over 100,000 households in Dadaab found that average daily firewood consumption per person was 1.4 kg for a three-stone fire, and that this dropped to 1 kg per person per day with the use of the Maedeleo stove (a reduction of 40%) (GIZ 2011).
- The impact of an ICS project in Karamoja in Uganda found that among the benefits cited by the beneficiaries was the efficiency of the stove in terms of both time and wood saving. Most informants, particularly in Moroto, reported using about one-third of the amount of firewood they had formerly used at the household level (Bizzarri 2011). Note that sometimes there is a discrepancy between perceptions of the users and the actual reductions.
- A reduction of over 50% in firewood consumption compared to traditional stoves such as the three-stone open fire was found following the SAFE intervention in Kakuma. The energy-efficient stoves, however, were found to be problematic when cooking traditional flat bread, a common food item among most of the refugee communities (WFP 2013a).
- The Berkeley Darfur Stove was found to reduce annual fuelwood consumption by 72% compared to a three-stone fire in stove tests conducted in Darfur under both windy and non-windy conditions (Amrose 2008).
- In a stove assessment in Darfur one of the benefits of improved cookstoves most commonly cited by IDPs was that they required far less wood and/or charcoal than traditional stoves, although this was not quantified. The same report stated that the promotion of mud stoves had reduced the amount of wood needed for cooking by 30–50%, but that the savings could be as high as 70% if certain improvements were made to the design and insulation of the stove (Langol 2005).

Alternative fuel stoves (ethanol, kerosene, LPG and solar) have all been tested in refugee/IDP camp settings but with limited reported results. An exception to this is the Project Gaia pilot projects on ethanol stoves, in which a number of evaluations have provided good data on the use of the CleanCookstove. In their pilot project that distributed ethanol stoves in Kebribeyah camp in Ethiopia, the provision of one litre of ethanol per day is said to have replaced between 95% and 100% of their firewood use (Rogers 2013; Lambe 2006). The average household consumption per new stove was estimated at 3.7 tonnes of fuelwood per year; total savings were then estimated at 6,600 tonnes per year. However, an assessment of the same stoves (the CleanCookstove) piloted in the Shimelba refugee camp, also in Ethiopia, determined that the amount of fuelwood used for cooking was reduced by 42%. In 50 households (out of 100 that participated in the pilot project), the average amount of fuelwood used per person per day declined from 1.81 kg to 1.05 kg (Egziabher 2006). This is partly because the new stoves cannot cook *injera*, one of the staple foods. The discrepancy in savings does create questions about the 100% savings noted above.

LPG and kerosene wick stoves were tested in Darfur. However, no baseline data had been collected on fuel consumption, so there were no quantifiable data on fuel savings. The only indicator used was that there had been 100% distribution of the stoves. Interviews undertaken with the users showed that the monetary and time savings were enormous, but these were not quantified. However, some users were scared of the fire risks and households reported difficulties refilling their empty LPG cylinders. The kerosene wick stoves were not popular and were not used (Hood 2007). Cookit's promotional fund claimed that two solar cookers could save one tonne of wood per year, but figures are not available from a camp setting.

As noted above, savings claimed are not always realized on the ground.[4] The Envirofit improved cookstove claims to reduce firewood consumption by up to 60%, based on lab testing. However, during controlled cooking tests in Kakuma the Envirofit was shown to reduce fuel consumption by only 30–34%. The range varies across user groups (Somali and Sudanese refugees and Turkana host population), which is primarily a reflection of their cooking habits, experience, and ability to make a three-stone fire more efficient (WFP 2013a). The Save80 improved cookstove reduces firewood consumption by up to 80% in lab testing; in field tests in Chad, as part of a UNHCR pilot, it showed firewood reduction of between 50% and 75%.

Promoters have also created numerous web pages and publicity campaigns that describe the positive effects of the stoves, or that offer training on efficient stoves. In many cases the basis for the claims is not given and in others anecdotal quotes are provided. For example, in Uganda, as part of support for gender and livelihoods, DRC reported that its work with households to construct energy-saving stoves resulted in a reduction in the use of fuelwood by about 50% (Danish Refugee Council 2013). In the Kobe camp in Ethiopia, ZOA International has distributed over 2,000 ICS, which it claims are already reducing firewood consumption by 50%. Experts involved claim that the savings could be higher (up to 80%) if proper training were provided (UNHCR 2011). Another example can be found in Goma in the Democratic Republic of the Congo, where Mercy Corps reports that the introduction of 20,000 improved cookstoves and improved food preparation techniques for IDP families has reduced consumption of firewood by about 50% – from a starting of point of roughly 7 kg a day per family. The organization claims that this has reduced carbon dioxide emissions by an estimated 24,000 tonnes (Mercy Corps 2008).

> There is a wide range of carbon emission savings claimed from improved cookstoves. These range from about 0.59 tCO_2e/year per stove up to 2.7 tCO_2e/year per stove.

Mercy Corps has put in place mechanisms to monitor its carbon dioxide reductions and has begun to generate carbon credits. Methodologies for measuring the carbon offset from the introduction of improved cookstoves have been designed under the Clean Development Mechanism (CDM). Improved cookstoves have been credited with a wide range of carbon emission savings. A review of approved CDM stove projects shows savings of between 0.87 tCO_2e per year per stove and 2.7 tCO_2e/year per stove. Few other studies of displaced populations include estimates of emission reductions. The annual carbon dioxide reductions related to the pilot project on ethanol stoves in Kebribeyah were estimated to be 6.2 tCO_2e, taking into account the emissions related to ethanol processing but not the emissions reductions due to land-use change (Debebe 2008). In an impact report from Energizing Development (EnDEV), GIZ, the German development agency, claimed that each stove provided saved up to 0.59 tCO_2e worth of emissions each year, although this figure was not specific to IDP or refugee camps (GIZ 2013).

A quick review of results outside IDP and refugee camps shows similar results to those listed above with varied efficiencies reported, mixed quality, cultural acceptance issues, and limited monitoring and evaluation in the field (Gifford 2010).

The findings show that where stoves are appropriate, accepted by the population and used correctly, they do result in fuelwood savings and likely associated environmental benefits. Based on the varying levels of emissions reductions reported, it is important that those who are implementing the projects set realistic objectives in that regard. However, the majority of projects

[4] Significant work is being carried out in this area to standardize stove performance and stove testing protocols. Further details are provided on page 43.

covered in the literature review have not systematically monitored carbon savings and in many cases the projects have not measured the baseline against which to track changes. An assessment of ICS programmes in Darfur carried out by ProAct Network also found that there was a general lack of monitoring and evaluation programming, although the projects had many positive results, including a strong uptake of the stoves (ProAct Network 2008).

Household lighting and other services

Where solar lighting replaces kerosene lights there is a clear reduction in emissions. However, no studies were found to quantify this in a camp setting. In development literature emission reductions are frequently cited as a justification for solar lighting projects. One of the most common figures used is the CDM default value of 0.092 tCO_2e/year for a solar light replacing a kerosene lantern, which is equivalent to 36 litres of kerosene a year. To put that in context, a camp population of 150,000 with four people and one lantern per household could reduce their emissions by 3,450 tCO_2e/year. Another CDM Programme of Activities project estimated that almost double that amount of kerosene would be replaced, based on an assumption of 0.053 litres per hour of kerosene lighting and 3.5 hours per household per day (Illumination Tanzania 2011). UNEP's en.lighten campaign, to transition to energy efficient off-grid lighting for all, estimates that solar lighting in Kenya would result in savings of 2.3 million tCO_2e/year, with a national annual saving of US$896.4 million (UNEP 2013). The reduction in kerosene consumption also reduces the emissions of black carbon, which is increasingly being recognized as a greenhouse gas emission.

> A solar light replacing a kerosene lantern can save 0.092 tCO_2e/year, assuming 36 litre of kerosene is replaced a year.

Lighting can also reduce fuelwood use where the fire is the only source of light. In focus group discussions in Pakistan, both men and women said that the introduction of solar lamps resulted in a reduction in the need for firewood.

If solar power replaces diesel fuel for battery and mobile phone charging and for the operation of small businesses, this will clearly result in emission savings. In camp settings, however, no studies have quantified this impact.

Camp infrastructure and management

There have been numerous institutional stove programmes, particularly for schools. In Ethiopia, UNHCR introduced institutional stoves in reception centres, schools and hospitals; the new stoves were said to have been more efficient than the cooking methods they were replacing, but this was not quantified. In other locations in Ethiopia the institutional stoves were not deemed successful although the stoves are between 75% and 90% more efficient than other stoves. There were a number of other issues relating to the use of the customary pots and ease of cooking, so many were no longer used. According to a WFP evaluation of a project that introduced briquette stoves in schools in Haiti, the initiative resulted in the complete elimination of charcoal consumption in over 60% of the schools.

PV is frequently used in schools and other centres but any environmental benefits have not been recorded, although there are clearly diesel savings. Similarly, PV pumping systems and solar street lighting have been deployed in a number of countries (including Lebanon, Kenya, Myanmar and Haiti).

Although such projects offset diesel-generated electricity, this impact has not been quantified. Solar-powered air conditioning is currently being used in Jordan, but no savings figures have been given.

The CDM methodology for renewable electricity generation for captive use and mini-grids (AMS-I.F) includes emission factors for the offset diesel generation that depend on the capacity and load factors of the current generation. These figures could be used for renewable energy in a camp setting and are shown in Table 2. As an illustration, the 36 kW PV system installed as part of a diesel hybrid by the UN Interim Force in Lebanon (UNIFIL) would save 76.8 tCO_2e per year if offsetting a large diesel genset.

Table 2: Emission factors for mini-grid diesel power generation

Emission factors for diesel generator system (in kg CO_2e/kWh*) for three different levels of load factors**			
Cases	**Mini-grid with 24-hour service**	**(i) Mini-grid with temporary service (4–6hr/day); (ii) Productive applications; (iii) Water pumps**	**Mini-grid with storage**
Load factors (%)	**25%**	**50%**	**100%**
<15 kW	2.4	1.4	1.2
>=15 <35 kW	1.9	1.3	1.1
>=35 <135 kW	1.3	1.0	1.0
>=135 >200 kW	0.9	0.8	0.8
>200kW***	0.8	0.8	0.8

Source: UNFCCC 2011.
*A conversion factor of 3.2 kg CO_2 per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories).
**Values derived from figures reported in RETScreen International's PV 2000 model retrieved from: http://retscreen.net/.
***Default values.

Clearly, the use of solar water heating can also reduce demand for other heating alternatives (fuelwood, diesel, electricity), yet there is little evidence of this in the literature. Following the earthquake in Abruzzi in Italy solar thermal panels were used for hot water in ten different IDP camps. An assessment of these systems showed that they met about 42% of the domestic hot water demand; carbon emission savings were estimated at 400 kg CO_2 (Micangeli 2013).

Security/protection

Programmes to introduce improved cookstoves and solar lighting have had stated objectives for mitigating protection risks, particularly gender-based violence, both inside and outside camps. Results of the literature review on this topic are provided below.

Sustainable energy interventions also improve protection by reducing the risk of fire from an open fire, kerosene lamps and candles. Although beneficiaries frequently cite this reduced risk, there has been no actual monitoring of the incidence of fires.

Cooking

Although many of the improved cookstove programmes have a stated objective of reducing the incidence of GBV, monitoring of these projects has focused on proxies (reducing the quantity of fuelwood use and reducing the frequency of collection trips outside camp, therefore reducing the risk of exposure), rather than measuring the occurrences of GBV incidents before and after the intervention. One reason for the lack of monitoring and evaluation of protection outcomes is difficulties in data collection. For example, in Darfur there is no effective centralized system for reporting information on incidents of gender-based violence and so there is no reliable information on trends in GBV (WRC 2006). Typically there is also no single actor to whom gender-based violence is reported, as found in Kakuma, Kenya (WFP 2013b). In addition incidents of GBV are often under-reported.

Mercy Corps claims that the training and construction of stoves in the camps close to Virunga National Park in the Democratic Republic of the Congo has 'dramatically reduced the number of attacks on women as they forage for wood,' but no evidence is provided to support this statement (Mercy Corps 2010a).

A recent study carried out by WFP on the SAFE fuel and GBV sensitization intervention in Kakuma had the following objective: 'To establish whether and how the provision of fuel-efficient stoves can reduce beneficiaries' exposure to risk of gender-based violence when accessing cooking fuel' (WFP 2013b). Owing to difficulties in reporting cases of GBV, the study used the same proxies. The study concluded that

> while the intervention had little impact on the distance and time away from home during firewood collection trips, the frequency of trips was reduced for both the refugee and host populations. The study provides preliminary evidence to indicate that a reduction in household consumption of cooking fuel thanks to the fuel-efficient stoves has led to fewer collection trips, thereby contributing to a decrease in exposure to risk of GBV. The frequency of firewood collection was found to be an important proxy in both the refugee and host community groups for exposure to GBV with evidence suggesting that there may be a reduction in the exposure to GBV with a reduction in the frequency of firewood collection.

In carrying out the study the authors were clear that there were numerous methodological and operational limitations, as well as the challenge of attribution.

Changes in behaviour or reported incidences of violence could be a reflection of factors outside the energy project. It is also important to note that travel outside camps is not restricted to fuelwood collection. It may be required for work as domestic servants in urban centres, for trade and market activity, or for collection of water and grasses. In addition wood is regularly collected for purposes other than cooking (Abdelnour et al. 2008).

As noted in the Environment section there is evidence that sustainable energy initiatives can lead to reduced fuelwood use, but whether this translates into a reduction in fuel collection trips is a matter of debate. In some cases – in Darfur, for example – women still collect fuelwood for sale. USAID reports that in Darfur in 2005, fuel collection trips were cut at least twofold (to two to three times a week). However, other reports suggest that women in the area continue to collect firewood, mainly for income generation (WRC 2006a). In his report on stove use in Darfur, Matthew Langol also mentions that there is a perception that those programmes have had little or no impact on GBV protection because women who were previously collecting wood for personal use are now doing so for income generation. However, he states that this is 'inconsistent with what most relief officials are reporting from the field and with statements from scores of IDPs who confirm that they are spending up to 50% less time on wood collection since completing ICS training' (Langol 2005).

Commonly reported reasons for no reduction in fuelwood collection trips include the following: continued collection of wood and grasses for additional income for cooking and non-cooking purposes such as construction or market sale; ineffective usage or a complete disregard of efficient stoves by beneficiaries; poor construction of some stove models, thus limiting potential fuel savings; and the absence of appropriate monitoring and evaluation of stove usage or protection outcomes. Some studies even suggest that the time savings have fuelled the growth of a secondary market for the sale of firewood (Abdelnour 2008).

> Studies in different camps have consistently reported that fewer fuelwood collection trips are made following the introduction of ICS or alternative stoves. WFP has found the frequency of firewood collection to be an important proxy for exposure to GBV with evidence suggesting that there may be a reduction in the exposure to GBV with a reduction in the frequency of firewood collection.

In line with the WFP and USAID findings in Kakuma and Darfur respectively, other studies in different camps consistently report that fewer fuelwood collection trips are made after the introduction of efficient or alternative energy stoves:

- A five-day evaluation interviewing 121 refugees was carried out following the introduction of 15,000 'Cookit' solar cookers in the Iridimi camp in Chad. The objective for the distribution of the stoves was to reduce reliance on fuelwood and in turn to improve the safety of the refugee women by reducing the need to leave the camp to collect wood. The main benefit of the project – which was noted by 80% of the women surveyed – was the improved security resulting from the decreased need to leave camp for firewood. Prior to the introduction of the solar cookers, which were used in tandem with an improved mud stove, the respondents took approximately 446 individual trips to collect firewood each week. Following the introduction of the cookers, this was reduced to 63 weekly trips (a reduction of 86%); 53% of the respondents no longer needed to leave camp to collect firewood (Loskota 2007).
- ICS distributed in the camps in North Kivu, Democratic Republic of the Congo were shown to have reduced collection trips by 50%, which was said to have reduced the exposure to protection risks (end report WFP Nzulu).
- Islamic Relief offered training on improved cookstoves in West Darfur. One woman stated: 'The training on improved cookstoves saved me from continuously having to collect fuelwood' (Islamic Relief UK 2013).
- The reduction in fuelwood use due to the introduction of ethanol stoves in Ethiopia had a far-reaching impact on the lives of refugee women and their families, as well as on the surrounding environment. Women and girls no longer needed to leave the camp to collect fuelwood (Debebe 2008).

Despite the absence of appropriate monitoring and evaluation of the outcomes it is clear that any improved cookstoves or alternative energy initiatives can reduce the exposure to GBV. To ensure that the energy initiative has an impact on a large number of women or on the frequency of collection trips, it should be implemented in parallel with other initiatives to increase income-generatng activities or to reduce the market for wood.

The removal of an open flame should result in fewer fires although there are no real monitored data on this. However, the ProAct Network study on stove programmes in Darfur did find that incidents of 'wild fires in camps due to open flames from cooking on the traditional three-stone fireplace' were common. 'With the use of fuel-efficient stoves, this has been reduced to zero,' the study said (Proact Network 2008).

Lighting

Although lighting (lanterns and street lighting) is known to prevent or reduce GBV, there are no scientific studies that have monitored the incidence of GBV before and after the introduction of a lighting initiative. However, surveys and assessments do show that women feel safer and appreciate the lights. Following the pilot launch of its Light Years Ahead initiative, UNCHR carried out a survey in three countries. The survey's initial findings included the following:

- 'Nearly all respondents commented that their previous source of lighting was a fire hazard and a health hazard to their families.
- 100% of respondents are able to use the solar lantern safely.
- 96% of all respondents now go less often to collect cooking fuel each week.
- 86% of respondents said the new solar lantern now allows them to study at night, something they could not do before.
- 60% of respondents feel safer using the bathroom at night' (UNHCR 2012).

IOM carried out a solar lamps assessment in April 2013 based on the Pakistan Floods 2012 Emergency Distributions Programme. A key conclusion from the assessment was that solar lamps addressed key protection concerns for women and children in temporary settlements, particularly in terms of reducing the risk of fire-related accidents. In addition, the report concluded that children and the elderly benefit from increased ease of moving at night.

In 2013, IOM and the University of Nairobi undertook a study of the 'Effectiveness and Sustainability of Solar Lanterns in Reducing Insecurity, Sexual and Gender Based Violence Cases among IDPs in Garowe-Puntland, Somalia'. Though the study primarily sought to determine the potential to use solar LED lanterns to curb the risk of sexual and gender-based violence at the household level at night, the low reporting levels of such cases of violence rendered the task almost impossible. The study, all the same, established that the solar lanterns were highly appreciated by the women (DFID 2014).

Caution must be exercised in some circumstances. In the Democratic Republic of the Congo, UNHCR have received feedback that IDPs do not use their solar lamps at night for fear of revealing their location to rebel groups. In the same country, women who had received NFIs with a value of $58 reported fear of attack by armed groups (IOM 2011).

Health

Numerous studies have assessed how the use of clean cookstoves has affected household air pollution (HAP) (WHO 2014). Studies have also provided evidence of links between HAP levels and health outcomes (WHO 2014). The majority have not been carried out in refugee or IDP settings but the results are applicable to any cooking situation. The applicability of the results depends on the stove as well as the camp cooking conditions (including the type of shelter, air circulation, cooking habits and humidity of available fuel). The degree by which stoves actually reduce smoke emissions differs greatly across the various types. Some, say with chimneys, can reduce emissions or at least emission exposure to almost zero.

The only studies found that actively measured HAP in IDP/refugee settings were carried out with the ethanol CleanCook stove promoted by Project Gaia. These studies were undertaken in 2009 to assess the potential of improved cookstoves to reduce indoor air pollution in the Bonga and Kebribeyah refugee camps in Ethiopia. The study monitored kitchen concentrations of PM2.5 and carbon monoxide (CO) – the two pollutants responsible for most of the ill health associated with indoor smoke – both before (with a three-stone fire) and after the stove introduction. Baseline CO levels were found to be high enough to contribute to mild headaches, fatigue, nausea and dizziness for a period of four to six hours. It was also found that following the introduction of the stoves, a quarter of the households continued to use the three-stone fire and most were using kerosene lighting. The results showed that the average particulate matter (PM2.5) concentrations decreased 84% (from 1,250 $\mu g/m^3$ to 200 $\mu g/m^3$ ($p=0.00$)) and average CO concentrations decreased 76% (from 38.9 ppm to 9.2 ppm ($p=0.00$)). Twenty-four hour average CO levels in households met, or nearly met, the World Health Organization's (WHO) eight-hour Air Quality Guideline; however, the PM2.5 concentrations were well above both the WHO 24-hour Guideline and Interim Targets. The study therefore concluded that despite the significant improvements further changes in stove or fuel type or household fuel mixing patterns would be required to bring particulate matter to levels that are not considered harmful to health (Pennise 2009) (Rogers 2013) (Egziabher 2006). The health implications of these improvements in indoor air quality cannot be quantified as this study did not collect any information on the participants' personal exposure or health status.

WFP claims that there was lower occurrence of some diseases associated with cooking in the three studied groups at the end-line period compared to the baseline period. The smoke emission from the use of the stoves was reduced, and their portability meant that people could cook outside the houses more easily (WFP 2013a).

GIZ also claims that an EnDev stove emits on average 30–40% less carbon monoxide and other pollutants than traditional stoves (GIZ 2013).

Other results relate to beneficiary responses to the advantages of the stoves:

- Respondents to a survey in Iridimi camp in Chad noted that an advantage of using the solar cookers was the absence of smoke, which had led to less coughing and fewer eye and nose problems. They also reported that the stoves were safer, with reduced risks of burns (Loskota 2007).
- Respondents to a survey in Darfur also cited that the ICS emitted far less smoke than the traditional stove. Owing to a reduction of heat and smoke, improved cookstoves also made cooking easier, cleaner and more comfortable (Langol 2005).

Beyond a humanitarian setting, GIZ found the same advantages: 'according to a study in Peru, 70.5% of traditional stove users complain of coughing attacks and 65.2% about eye infections. Among the users of improved modern stoves, only 6.1% and 3.3% respectively are affected.' (GIZ 2013)

Similarly there have been reports of a reduced occurrence of burn-related injuries among children and women after the introduction of improved stoves, but quantifiable evidence of this (e.g. rate of occurrence before and after) was not found in the literature. Rather, evidence is from beneficiaries citing this as one of the advantages.

Another benefit of introducing efficient or alternative energy stoves is that they enable families to skip fewer meals and sell less food, which clearly has an impact on their nutrition. Following the introduction of the solar cookers, food rations have rarely been sold or exchanged for fuelwood and the low-maintenance food preparation frees up time for other activities (Loskota 2007).

Livelihoods and resilience

There is evidence in non-IDP/refugee settings that access to any modern source of energy helps to develop economic enterprises, secure livelihoods and increase resilience. In camp settings the literature focuses on productive activities related to stove manufacture as well as on ICS-related time savings, which allows time for income-generating activities (IGA). However, there is no actual monitoring of these new income-generating activities. Livelihoods are also improved when there is additional money available as a result of savings from fuel purchases. There is also survey evidence that light at home and portable solar lanterns allow further activities to be carried out after dark including IGA. More frequently, however, the longer hours with light are used for cooking, collecting water, looking after children, and study.

A programmatic review of improved cookstoves in Darfur carried out by ProAct Network in 2009 identified four key areas where stoves targeted livelihood security and resilience. These were time savings, cost savings, sale of stoves and payments per stove produced.

Time savings have been identified in many of the stove programmes. A reduction in fuelwood consumption directly reduces the frequency or distance of collection for own household use. In some cases the number of trips is recorded (as noted relating to protection) and in others an estimate of the time and distance travelled is measured.

> In Ethiopia significant savings were noted following the introduction of the CleanCookit stove. Prior to its introduction the reported distance and amount of time travelled while collecting fuelwood was 4,966 km/month and 1,659 hours per month. Following the stove introduction the distance and amount of time travelled in one month were reduced to 1,968 km and 732 hours. The interviews showed that trips per month decreased in all surveyed households. There may be a compounding effect in that smaller quantities of firewood would be more easily gathered closer to camp, while larger amounts of firewood would require gathering further away from camp.
> **(Egziabher 2006)**

In theory this new time can be used for income-generating activities; in reality, however, the extra time is likely to be used for other activities such as child care and domestic chores, which still have value, particularly for women. No evidence of the additional income or actual activities was found. Outside humanitarian settings there are also limited data on livelihood impacts for women from stove programmes.

- In the end-line survey of the WFP SAFE project in Kenya the refugee and host community participants reported that time saved thanks to fewer firewood collection trips was used to care for children, perform domestic chores, bond with family and friends and, to a lesser extent, for income-generating activities (WFP SAFE Kenya).
- Similarly in Ethiopia time savings from less fuelwood collection resulted in women having more time to do other household chores, care for their children, enrol in literacy classes, pursue income-generating activities and other interests that enhance quality of life. Only 46% of the households said that they used the saved time for income-generating activities (Egziabher 2006).

- Among the benefits of improved cookstoves most commonly cited by IDPs in Darfur included an increase in the amount of time available for other activities such as washing, adult education and income generation. They also stated that there was an added advantage of time saved because the new stoves cut cooking time in half (Langol 2005).
- When asked hypothetically what they would do with their new spare time, one mother in the Kenya ECHO project answered, 'I will be at home more and make baskets that I will sell. The money I will use to buy more food' (McDowell 2009). In another study that asked the same question, about half the women said they would use the increased available time to collect wood to sell, while most of the other 50% said they would do other IGA or work in the nearby town of Nyala, or use the time to rest (Galitsky 2005).

Cost savings ensue where fuel is bought frequently. Reports quote fuel and cost savings but do not necessarily quantify them. The ProAct review in Darfur, using a proxy indicator of cash surplus per week, found that in all three Darfur states there was at least a 50% cash savings made on fuelwood purchases when a truly fuel-efficient stove was used (ProAct Network 2008). The full adoption of the Berkeley Darfur stove was reported to result in monetary saving of US$222 per family per year for IDPs who buy fuelwood, or a saving of 18 hours of effort per week for those that collected. According to the evaluation of the Solar Cookit stove, beneficiaries reported that they saved nearly US$7 a month. In South Darfur, IOM, the UN Children's Fund (UNICEF) and the UN Industrial Development Organization (UNIDO) jointly trained 10 IDP women in El Sereif camp on the use of solar cookers in 2007. IOM then monitored this group on a weekly basis. The initial findings showed that the solar cookers were used in addition to the usual charcoal and firewood but that the women did have more money available to spend on wood and charcoal; an added advantage was that less water was required (IOM 2007).

In another study in Nzulo, improved stoves allowed the beneficiaries to save money by reducing the firewood needed for cooking, in comparison with the three-stone fire. However this reduction was not quantified (End report WFP Nzulo).

There are no data from camps on how much money people save on kerosene purchases or mobile phone charging following the distribution of solar lanterns. Without a clear baseline for this expenditure it is difficult to estimate the savings. Outside camps in East Africa, however, weekly costs for kerosene and charging are estimated in the region of US$1.40 to US$1.75. Where lanterns are distributed for free all of this saving could be available to the households. Where the private sector provides energy services outside camps in East Africa, these same energy services can cost between US$1.30 and US$1.50 a week. In India, limited services from a micro-grid can be as low as US$0.40 a week.

The production and sale of ICS is another potentially important income-generating activity, either for camp residents or for local populations. There are limited quantifiable data from the camps. Where these exist, they show mixed results. One of the trainees in WFP's SAFE programme in North Darfur, which provided training to make simple stoves and fire briquettes, reported that she had made about 250 improved cookstoves to sell in the local market at either 10 Sudanese pounds (approx. US$1.50) or 7 Sudanese pounds (US$1) depending on size (WFP 2014). However, in a project in Rwanda it was found that the stove producers could not sell their product at the level anticipated owing to the poverty of the population in the targeted area. Despite this their incomes were increased marginally (Munyehrie 2011).

Payments per stove produced: Some projects include training of women to manufacture ICS and as part of the intervention the implementing agency will pay the women for each stove produced (cash for work).

New jobs and enterprises: The availability of electricity can drive economic enterprise. In the Jordanian camps, where there is electricity, there are flourishing markets and businesses. The introduction of sustainable energy can equally create jobs; for example, an entrepreneur may purchase a PV panel to start a business charging mobile phones. Digicell in Haiti has shown the potential for job creation through its mobile charging model in which it employs local residents as the entrepreneur. Another example is IOM, which established a hybrid renewable energy and market centre in Dadaab. The centre, which has created jobs for three youths, has an IT facility that offers training (IOM 2011).

Longer opening hours: Solar street lights in Hagadera, Dadaab are reported to be appreciated by the local traders as they directly contribute to increased profits (UNHCR 2014b).

Education: A number of surveys show that solar lamps improve IDP and refugee living conditions. Beneficiaries have reported that solar lamps allow students to study at night at home, which had not been possible before (UNHCR 2012; IOM 2013).

Economic and energy security benefits

Although not included in the initial research questions, one clear advantage of sustainable energy initiatives is the economic benefit derived from reduced purchases of more expensive fuels. Where the economic benefit falls to the IDP or refugee this information has been included in the previous section on livelihoods. However, the economic benefit to the implementers or camp managers could be significant. The literature review therefore also covered this very important aspect.

Site infrastructure and management

Any initiative to reduce the use of diesel fuel for generators (and fuel for institutional stoves) will reduce the operational costs of the camp. Although there has been some work in this area in IDP and refugee camps (as described on page 15) there is not yet any publicly available information on the savings achieved. In Dadaab, UNHCR and partners have piloted various solar-based energy solutions in order to save fuel costs (see case study).

For similar situations (such as peacekeeping troop camps), a study undertaken for the UN Logistics Base's Engineering Standardization and Design Centre (ESDC) calculated that a solar water system would pay back in less than a year with minimal operations and maintenance requirements (ESDC 2013). ESDC has also estimated that by using efficient batteries, conventional generators, and PV it would be able to save 50% of its fuel with a return on investment in less than eight years (ESDC 2014). UNIFIL has installed PV at its camp in Lebanon. It estimates that its 36 kW system (generating 95 MWh per year) will provide a return on investment in less than six years based on current fuel costs (UNIFIL 2012).

NATO is also trying to raise awareness of the energy challenge related to the high costs of transporting fuel and the associated security risks (such as attacks on convoys). It has established the Smart Energy Team (SENT) to look at more energy-efficient solutions for military camps, including cooling and heating tents, adjustable load generators, management systems, heat pumps, floor heating, insulation materials, and methods of storing energy. LEDs and 480m^2 of PV panels were installed in Afghanistan in 2012, generating 200 kWh/day. According to the team, the investment paid back in nine months (NATO 2013).

There are examples of renewable energy hybrid systems saving costs outside camp environments. Although numerous PV-hybrid mini-grids have been installed there are limited data on the actual payback for these systems. The Institute of Economic Development (IED) has analysed a number of sites for the UK government's Department for International Development (DFID) and found that the levelized cost of energy varied between US$0.27 per kWh and US$0.60 per kWh for electricity delivered from PV-diesel hybrids, compared to variations of between US$0.40 per kWh and US$0.60 per kWh for diesel only (IED 2013).

Case study 2: Solar water pumping in Dadaab

Solar hybrid pumping systems have been installed at two of the 30 boreholes in the Dadaab camps. 27 of the other boreholes still function on diesel powered generator, while one is on standby. At each of the 29 boreholes discharge varies between 25 and 60m^3/hr from a depth of 150–180m delivering about 10,000m^3 of water per day in the five Dadaab refugee camps.

The first system, installed at Hagadera, pumps between 160 and 192m^3 of water from the borehole to an elevated steel tank on a sunny day. A diesel generator operates on cloudy days to supplement the solar panels. This has reduced diesel fuel consumption by up to 60% although actual fuel savings are not given.* The experiences gained with these systems will be used to install solar at the remaining 27 boreholes.

UNHCR cite the benefits of photovoltaic solar–diesel hybrid systems as:

- Improved reliability and energy services
- Reduced emissions and pollution
- Continuous power supply
- Increased operational life
- Reduced cost, and more efficient use of power (UNHCR 2014)

* In a separate initiative water provision has been reduced by 18% per person, down to 22 litres per day, and this has resulted in 515 litres of diesel savings a day at a cost of 112 KEW/litre, resulting in monthly savings of 1,730,400 KES or annual savings of US$230,000. Therefore 60% savings in fuel from PV could result in substantial savings across the site.

Another example in Australia shows how the price of solar system components has been reduced to the point where solar/diesel hybrid generation has now become economically viable for remote mini-grid generation in the Northern Territory (NT) when compared to diesel-only generation. Local electricity utilities installed solar in their existing diesel mini-grids to achieve diesel fuel savings and reduce on-going operational costs and diesel fuel price exposure. In addition, incorporating solar into existing diesel mini-grids may increase power supply security. Many remote mini-grids in the NT are inaccessible for months at a time during the wet season, and rely on stored diesel fuel for power generation. The use of solar to offset diesel fuel consumption may extend the time the stored fuel can last, increasing supply security (Power and Water Corporation 2014).

The economic benefits have also been shown to increase project sustainability. In one Oxfam-funded system, the water committee uses the savings to maintain other facilities.

Host populations

There is some evidence that tensions are reduced between host populations and refugee/IDP populations as a result of decreasing the reliance on local natural resources (through stove programmes) and also from the inclusion of the host population in energy programmes. The study reviewing challenges to fuel supply in camps found that the introduction of energy-efficient stoves had a positive impact on refugees' relationships with both the local population and the authorities in Chad; similar improvements were seen in Kenyan refugee camps as a result of energy-saving stoves being provided to refugees and the local community. The policy of refugees buying additional firewood from the local community has also improved relations between the two parties. The establishment of environmental working groups with both refugee and host members also improved relations between the communities (Lyytinen 2009).

Energy programmes are normally targeted at the host community as well as the displaced population so they experience the same benefits described above. However, in some cases the results can be different. For example, the findings from Kakuma showed a reduction in trips by the refugee population but there was no reduction in the rate of fuelwood collection among the host population, which continued to collect to boost its income (WFP Kenya Update: April 2013).

There have been negative consequences from energy programmes, for example when an agency takes responsibility for the supply of fuel. In Dadaab there was resentment towards the agency-managed programme of firewood supply from locals who were not benefiting because contractors bring in labour from the camps and the contracts further increase competition for the available resources. The provision of donkey carts by the Arid Lands Resource Management Project (ALRMP), which was meant to encourage local participation in the firewood trade, has provided important income-generating opportunities for some host community members, but the scale of this support has been limited (Danish Refugee Council 2010).

Gaps in evidence/literature

The above sections provide an indication of the impacts that sustainable energy can have on refugee and displaced population camps. Some of these impacts come directly from literature on camps, while some are extrapolated from development literature. What is clear is that the evidence of these impacts is patchy, not systematic and often anecdotal. **The clearest evidence is that in most cases a real reduction in fuelwood use results from the introduction of ICS or alternative energy stoves.**

A previous study assessing the effectiveness of 17 improved cookstove programmes in Darfur found that because the ICS programmes were often embedded in a larger programme the monitoring of the specific ICS component was weak (Proact Network 2008). The limited mechanisms in place often simply note the number of stoves distributed (which is recorded in a register); they sometimes track fuelwood savings, either directly or as a proxy. Other impacts of the stoves are not measured. Changes to the local environment or to the occurrences of GBV outside camp have not been monitored directly. Similarly economic opportunities as a result of a stove programme (other than in stove production) have not been reported. There is an opportunity to collect some of this data in a camp setting. For example, in the case of security/protection, individual counselling, focus group discussions, clinical reports and civil police reports are possible mechanisms for measuring change. For projects with the environment or economic opportunity as their objective, household surveys, home visits and formal assessments are among the mechanisms that could be used to measure change.

The Interagency Safe Access to Fuel and Energy (SAFE) Steering Committee is a consortium of key partners[5] with a mission to facilitate a more coordinated, predictable, timely, and effective response to the fuel and energy needs of crisis-affected populations.[6] Its strategic interventions include advocacy, fundraising, capacity-building, and development of tools and guidance. The SAFE initiative recognizes the gap in evidence described. In the second phase of the Global Alliance for Clean Cookstoves (GACC) strategy, the organization proposes to do the following:

- Conduct assessments on appropriate stoves and fuels in focus countries;
- Commission research on GBV, burns and livelihoods; and
- Support the development of SAFE monitoring and evaluation indicators.

In addition research is needed on the link between reduced fuelwood use and the actual impact on the local environment.

The literature review revealed no studies that have monitored changes in outcomes due to solar lighting. Similarly, no studies were found to have assessed the use of sustainable energy in camp infrastructure and management. Similar assessments and research as outlined for stoves are needed to provide evidence of the links between sustainable energy initiatives in camp settings and the purported impacts. This research should encompass fuel savings, operating costs, economic impacts, environment, education, security and protection (including GBV), health (including nutrition, burns and fire) and livelihoods.

UNHCR is also in the process of designing tools and relevant indicators to collect further evidence of the effectiveness of its energy-related activities, particularly of Light Years Ahead (which includes solar street lights, solar lanterns and ICS).

[5] Food and Agricultural Organization (FAO), Global Alliance for Clean Cookstoves, International Lifeline Fund (ILF), Mercy Corps, ProAct Network, United Nations High Commissioner for Refugees (UNHCR), United Nations Children's Fund (UNICEF), UN World Food Programme (WFP) and Women's Refugee Commission (WRC).

[6] The history of SAFE and its activities is included in more detail in the companion policy and practice paper, S*ustainable Energy Provision Among Displaced Populations: Policy and Practice*. Further information can also be found at http://www.safefuelandenergy.org.

Potential and Opportunities for Improved Access to Sustainable Energy for Displaced Populations

This section reviews where there is potential for sustainable energy options for displaced populations focusing on a) energy technologies which may be appropriate to humanitarian settings, and b) the opportunities for the private sector to effectively deliver these sustainable energy options. It does not provide detail on the current approaches to energy provision in camps but instead looks at innovations in energy delivery and their potential to be used by the private sector in a humanitarian setting. There may be opportunities in other areas such as improvements in the current approaches to energy provision in a humanitarian setting, and this is dealt with in the companion paper on policy and practice.

Technology opportunities for sustainable energy options

- The potential for renewable sources of energy and sustainable energy solutions is specific to the location and depends on a number of situational factors including resource availability, affordability, ease of access and local capacity to absorb and maintain the technology.
- Appropriate sustainable energy solutions, and how they are delivered, are constantly evolving as technology develops and costs are reduced.
- Technology options include significant energy efficiency measures, stand-alone products and mini-grid options.
- Costs are product- and site-specific but sustainable energy can be cost-effective and reduces operational costs.

Opportunities for the private sector to deliver these sustainable energy options effectively

- The greater involvement of market mechanisms in energy delivery is likely to result in more choice for the camp residents and signifies a move away from a more paternalistic, or dependency, approach where the residents have few options and no choice.
- Opportunities exist in camps for private-sector actors owing to the large concentrated markets although the market potential depends on the disposable income of the population, its current energy provision and needs. Disposable income varies widely between camps.
- There are a number of innovations in energy delivery which could be applicable for humanitarian settings. These models have found a way to address one of the key barriers to energy access – the relatively high upfront cost of the technologies, which is unaffordable to households that budget on a daily basis.
- Delivery models with potential for adoption for camps include low-cost entry-level energy products, micro-grids, energy as a service on a pay as you go (PAYG) basis, leasing products, consumer micro-credit and central charging services.

Potential and opportunities for sustainable energy technologies

Factors affecting options for access to sustainable energy

The potential for renewable sources of energy and sustainable energy solutions is specific to the location and depends on a number of situational factors including resource availability, affordability, ease of access and local capacity to absorb and maintain the technology. It will also depend on the energy services required and on the cultural, social, and political context in each locality as not all technologies are appropriate or adaptable and cost-effective for particular end-uses. As the Ashden Awards say, energy solutions should be 'affordable, accessible and aspirational'.

Although camps have recognizable patterns, they are not homogeneous; each to some extent is unique. What may be appropriate technology for one camp may not work for another. From an environmental perspective the availability of natural resources will affect the choice of technology. The availability of local fuelwood, the current cooking methods, and the risks associated with fuelwood collection will all help to determine what is an appropriate cooking solution. Ethiopia is endowed with natural resources such as sugar cane, which means that alcohol fuel is a possibility, whereas Sudan has access to cheap LPG. Although carbon-based, LPG can be an appropriate option where it provides improved energy access and reduces the reliance on diminishing forest resources. Many camp areas receive good sunlight for solar technologies; indeed, sub-Saharan Africa receives more consistent sunlight than other regions.

Social and cultural sensitivities will affect the selection of cooking technologies. For example, solar cookers must be operated outside, which may not be culturally appropriate, and biogas systems that require human waste may not be accepted by the users. Cooking practices affect what will work in practice. A technology may work efficiently in tests but, in the field, camp residents may use the technology in ways that undermine the efficiency gains. For example, women in Haiti like to leave the fire to carry out other activities, which means they do not tend the fire as expected by the designers.

Solutions, whether for shelter or energy, must be both appropriate for beneficiaries and acceptable to local authorities. Where permanent structures are not allowed this will limit some of the opportunities, unless the host authority can see a longer-term benefit for the host community. For example, a mini-grid could power the local community as well as the camp. In such a scenario, the technology will be there for the country long after the refugees or IDPs have returned home. If the national grid is likely to extend closer to the camp, then any power generation could also provide future power to the grid.

Energy should not be viewed in isolation but as part of a wider camp system. In particular, there are synergies relating to waste management, water and energy where a holistic approach may be more appropriate. Any solution should use lessons learned to date, should build on successes and should, of course, demonstrate good engineering practice and be culturally appropriate.

Technological developments and cost reductions

Appropriate sustainable energy solutions, and how they are delivered, are constantly evolving as technology develops and costs are reduced. In recent years, such changes have been occurring rapidly in solar light technologies, but the same is true for energy management, low-load smart meters, mobile money, fuel cells and battery technologies. These changes mean that it is not possible to draw a line and list all of the appropriate sustainable technologies. There will be continuous developments that will need to be taken into account.

The cost of solar panels, batteries and light-emitting diodes (LEDs) has dropped considerably over the past five years, with solar panels about half the price they were in 2008 (Winiecki 2014). This trend is likely to continue; Lighting Africa estimates that the average portable solar lamp sold in 2020 will have double the battery life, five times the brightness and cost a third less than similar products on the market in 2012 (IFC 2012a). At the same time progress has been made on the reliability of solar and related products with the average useful lifetime of batteries and solar products increasing in recent years. Several leading manufacturers now offer a three-year standard full warranty covering full product replacement (Winiecki 2014). At the same time, there is increasing acceptance of the products as they become more widely available; in Africa over four million solar lighting products were sold between 2009 and 2012, with annual sales growth at almost 100% per year (IFC 2012a).

These innovations affect technology choice but they also have an impact on the way energy is delivered to the final customer. Recent technology developments have increased the attractiveness of a number of energy delivery models, such as pay-as-you-go, detailed on page 58.

Existing tools and protocols to assist in selecting sustainable energy options

Tools

A number of publications and tools are already available to help humanitarian workers select appropriate sustainable energy options. With stove programmes, for example, the choice of stove depends on a number of contextual factors; there is clearly no one solution that fits all. As recognized in the SAFE approach, a comprehensive understanding of cooking fuel needs as part of the baseline will enable the design of a robust approach that actually does improve protection, as opposed to being based on an assumption that a stove alone will do so (as seen in the results of the literature review). The SAFE task force of the Inter-Agency Standing Committee for humanitarian assistance (IASC) designed several tools to help implementers conduct this type of robust baseline assessment before designing a cooking intervention. A number of guides have been produced on how to select the appropriate stove and cooking fuel strategy, specifically by USAID, UNHCR, IASC and WFP (IASC April 2009; WFP 2012; UNHCR 2002a; USAID 2010). One of these (IASC SAFE task force) designed a decision tree diagram to help with the selection of a cooking fuel strategy for acute emergencies and in protracted settings. This provides a very good approach to assessment, as it takes into account a number of considerations.[7]

For non-household energy use there are a number of guides available that could be applied, or adapted, to a humanitarian situation. For example, UNEP has produced a guide on energy efficiency and renewable energy options for peacekeeping troops – *Greening the Blue Helmets* (UNEP 2012) – and USAID has published guides on powering health centres and clinics (USAID 2009).

Although these tools exist there is limited knowledge of their existence and staff would need training in their use. Using these tools correctly can help to avoid the design and implementation of inappropriate interventions.

[7] All these tools are available at http://www.safefuelandenergy.org/resources/index.cfm.

Standardization and testing protocols

As detailed earlier, there have been variable results relating to actual stove efficiency improvements. The few existing protocols for testing stoves vary from country to country, which makes it difficult for a programme designer to assess a stove's true performance. As a result, significant work has been undertaken to develop an international agreement on the standardization of stove performance and stove testing protocols, to be certified by the International Standards Organization (ISO). The categories in which performance is measured under this International Workshop Agreement (IWA)[8] are fuel use, emissions, indoor air quality and safety. For these categories, work has gone into the development of tiers, so that stoves can be classified according to quality. Products range from tier 0, having no improvement over the baseline stove (usually the three-stone fire), to tier 2, having substantial improvements, and tier 4, stretching goals for targeting ambitious health and environmental outcomes (Energypedia 2014).[9] Further tests will be developed relating to durability, climate impact and field testing.

Standardization of stoves and their performance will make comparisons easier. In addition, to help programme designers, there is an online Clean Cooking Catalogue that lists stoves along with their key indicators such as stove features, specifications, emissions levels, efficiency, and safety from laboratory and field-testing.[10]

Similarly there has been considerable work on testing and performance of off-grid solar lighting products as a direct result of the identified market threat to quality lighting products from the influx of poor-quality lighting products into Africa. To counter this risk of market spoilage, Lighting Africa developed test methods and Minimum Quality Standards for modern LED-based off-grid solar-powered lights; these served as the foundation for the now global International Electrotechnical Commission (IEC) Technical Specification 62257-9-5.[11] There is also an online catalogue on the Lighting Global website of all of those products that have met the Minimum Quality Standards. This makes it possible to select pre-tested, quality-assured products (Lighting Global 2014).

Sustainable energy technology options for displaced populations

A number of energy options are available to meet displaced populations' energy needs more sustainably; many of these are already being used. Table 3 includes the main options that are currently commercially available. The solutions vary between stand-alone options (lightly shaded) and system or mini-grid solutions (darkly shaded). As described above, new technologies are continuously changing the options available.

[8] The International Working Agreement (IWA) was drafted by PCIA in cooperation with the Global Alliance for Clean Cookstoves (GACC).
[9] These tiers area available at http://www.pciaonline.org/files/ISO-IWA-Cookstoves.pdf.
[10] Available at http://catalog.cleancookstoves.org/.
[11] The International Electrotechnical Commission is the world's leading organization for the preparation and publication of international standards for all electrical, electronic and related technologies.

Table 3: Example of sustainable energy solutions to meet household energy service needs

Household energy service	Energy efficiency options	Renewable energy options		Other options/low carbon	
Cooking and heating	• Improved cookstoves (ICS)/Fuel-efficient stoves (FES) • Communal kitchens • Improved cooking practices	• Alternative fuel and stoves – biomass briquettes, solar, ethanol, biogas		• Alternative fuel and stoves – LPG	
Shelter	• Insulated shelters				
Lighting	• LEDs	• Solar lanterns/ pico solar • Solar home systems Integrated PV	• Mini and micro-grid electricity from wind, biomass, biogas, PV, hybrids	• Central charging • Pedal power	• Mini-grid electricity from more efficient gensets • Grid electricity
Communication and other electricity services					
Productive uses	• Improved cookstoves (ICS)/Fuel-efficient stoves (FES) • Improved cooking practices				
Water pumping	• Efficient pumps	• PV pumping/sterilization		• Hybrid pumping	

Numerous sustainable energy options are also available to help meet camps' operational energy needs. Table 4 includes the main options that are currently commercially available and that could be deployed in a camp. As with the displaced populations the solutions vary between stand-alone options and system or grid solutions.

Table 4: Example of sustainable energy solutions to meet camp operation energy needs

Energy services for	Energy efficiency options	Renewable energy options		Other options/low carbon	
Health, education and community centres	• Improved institutional cookstoves (ICS)/Fuel-efficient stoves (FES) • Insulated buildings • Energy management	• Alternative fuel and stoves – biomass briquettes, solar, ethanol, biogas • Stand-alone PV systems • Solar AC/ chillers/Solar water heating	• Mini- and micro-grid electricity from wind, biomass, biogas, PV, hybrids	• Alternative fuel and stoves – LPG • Energy storage	
Security, lighting, communication, water pumping and waste management	• Energy management • Increased efficiency	• PV street lighting • Biogas systems • PV water pumping • Stand-alone PV systems	• Mini- and micro-grid electricity from wind, biomass, biogas, PV, hybrids	• Mini-grid electricity from more efficient gensets • Energy storage • Grid electricity	
Administration and logistics	• Energy management • Increased efficiency	• Solar water heating • Biogas systems • Stand-alone PV systems	• Mini and micro grid electricity from wind, biomass, biogas, PV, hybrids	• Alternative fuel and stoves – LPG	• Grid electricity • Mini-grid electricity from more efficient gensets

One of the common features of these technologies is that they are almost all appropriate for protracted settings and recovery but also during the acute phase of an emergency. The method of delivery may change with the phase of the emergency but the technologies can remain the same.

The technical potential for these technologies would be widespread up-take in all camp settings; however, the likely potential will be lower than this owing to various challenges and barriers to adoption (including financial, regulatory, practical, cultural and social issues).

A brief overview of some of these technologies and their applicability, challenges and advantages is provided in the following sections. This is not intended to be a comprehensive list since there are numerous documents that provide full details on the technologies.

Cooking

Improved cookstoves (ICS)

There is significant experience worldwide with numerous types of ICS, which have been used in refugee and IDP situations since the 1990s. Lab tests of improved cookstoves show fuel efficiency gains of anywhere from 5% to 80%.

ICS can be categorized in a variety of ways, based on design principles, construction materials, fuel type and other characteristics. Improved cookstoves are usually made with more sophisticated materials such as metal, fired bricks, or combinations of clay soil plus straw, cow dung, sawdust or rice husks to improve insulation and durability. They are often portable and some designs incorporate features for smoke removal, such as a chimney. Some have complex design features and must be made by specialists, while others can be built by end-users themselves with appropriate training. Regardless of who makes the stove or where it is produced, users generally will need guidance to operate an ICS properly and obtain the maximum benefits possible.

Alternative fuels

Alternative fuels include alternatives to biomass such as briquettes (which can be made from a number of materials including waste paper, animal dung and sawdust), charcoal or grass, ethanol, jatropha oil and biogas. Other options that are sometimes appropriate include kerosene and LPG, although these are not carbon free and many consider the use of petroleum products as household fuel in camps to be too much of a fire hazard (Hood 2007). As with other stoves noted above, the appropriateness of any option depends on many factors.

Biogas

Biogas systems can contribute to waste management while producing useful fuel in the form of biogas. They can be integrated directly into the systems for both waste (e.g., latrines) and kitchen waste. The biogas produced can be used directly for cooking or heating or it can be used to generate electricity. Traditionally biogas units are designed as permanent features; therefore, they can be difficult to use in camps that are intended to be temporary. In addition, given the relatively high investment costs, the use of biogas may only make sense in protracted situations. Portable and low-cost plastic tubular biogas systems could be a solution to this. A recent study has reviewed current biogas technologies and processes in order to select a suitable technology for use as a portable system. Its findings selected one technology as suitable for a portable biogas unit but also stated that further work is needed, including further mathematical modelling, selection of suitable construction material, and economic feasibility studies (Taylor 2010). According to another study, low-cost plastic technology may be appropriate where there is local indigenous experience and expertise in designing and managing such plants, but it is not appropriate for the majority of emergency situations, where this expertise is not available (Harvey 2007).

In addition to cost considerations and questions related to skills for maintenance and construction, there are also clear issues with regard to social acceptance. UNHCR has been piloting biogas in Bangladesh with the aim of treating waste and reducing wood consumption for cooking. To date, 15 units have been installed and the agency estimates that fuel consumption has been cut by a third, based on the fact that families cook one of their daily meals using the biogas. The gas is provided for free for cooking at a communal kitchen with a rota for use. UNHCR promoted acceptance of the gas by persuading religious and community leaders to demonstrate the use of the biogas. In contrast, Somalis refuse to cook on gas created from human waste; however, there may still be the potential to use the gas in electricity generation in Somali camps (McCallion 2014). In Eritrea, biogas is used to heat plates for the cooking of *injera*.

Case study 3: Mixed success of improved cookstove programmes in Uganda

In Northern Uganda an evaluation of fuel efficient stove (FES) programmes has shown that realizing the benefits available from FES to IDPs can be complex, and past programmes have had mixed results. USAID evaluated three types of FES being promoted by four different non-governmental organizations (NGOs), to ascertain whether the stoves were really reducing fuel consumption. The evaluation revealed that not all stoves being promoted in Northern Uganda were appropriate, nor were all FES programmes being implemented appropriately. Key findings of the evaluation included:

- ‘All of the NGOs had succeeded in disseminating stoves to large numbers of camp residents despite working in difficult conditions.
- Stove efficiency tests conducted by the evaluation team could not verify fuel saving claims reported by the evaluated NGOs. Some of the stoves tested consumed more fuel than the open fire.
- Implementing NGOs had insufficient quality control systems in place to guide their programmes.
- Few NGOs had collected baseline data, monitoring and evaluation procedures were weak, and too much emphasis was placed on quantity, rather than quality, of stoves produced.
- Many field staff are overburdened, and lack the requisite time and technical expertise to successfully implement FES programmes. Headquarters support was largely non-existent, especially for programmes in which FES were just one component of a broader strategy (i.e., food security, livelihoods).
- NGOs that sought to standardize stove production, via paid specialist staff or mass production techniques, were better able to maintain design parameters critical for efficient combustion than NGOs that relied on beneficiaries to build their own stoves.
- Implementing NGOs need to spend more time on end user education, to ensure behaviour change messages are transmitted effectively and that beneficiaries know how to use their stoves to obtain maximum benefits.’

Although the IDPs welcome the potential benefits of the FES there are clear lessons to be learned from the findings, in particular with regard to the need for clearly demonstrated savings in the appropriate context, the need for training, for quality control and monitoring and evaluation.

Based on USAID’s Summary Evaluation Report of Fuel-Efficient Stoves in IDP Camps, September 2007.

Solar

The solar cooker is another option that has been used with mixed success. There are a number of different types of stoves – box, panel and dish. In many cases solar cookers have not been accepted because of their slower cooking times and the need to be outside to use them. A survey in Chad found that the solar cookers were capable of cooking the same food that would have been made on a wood-burning stove in the past; it also found that the women considered the solar cookers safer than wood-burning stoves. However, since solar cooking is slower than wood-burning methods it requires greater planning; moreover, weather affects the ability to use the cookers as well as their lifespan, which is currently only two to three months (Loskota 2007).

Institutional cookers

Efficient stoves and alternative fuel stoves are both options for large-scale institutional cooking. An additional technology, the large concentrated solar cooker, is gaining ground in India in institutional settings. The technology is modular and relatively mobile but requires space and, to ensure sustainability, specific training in both use and maintenance. However, this technology could be appropriate for camps.

Energy efficiency

There are numerous opportunities for energy efficiency improvements, optimized energy management and behavioural change, in addition to the installation of renewable energy. Savings could be made through education and behavioural change without any investment in technology. There are clear options for redesigning structures and systems, adding metering and sensors, and procuring low-energy and water appliances. Fuel-efficient diesel generators could be procured. Several examples of ways to improve energy efficiency in a camp setting were provided in an assessment of energy, water and waste reduction options that was carried out for peacekeeping camps in Mogadishu, Somalia and Mombasa in Kenya (UNEP, DFS and UNSOA 2010). Best practice would be to reduce energy demand prior to designing and sizing the energy supply system.

Lighting and other electricity services

Stand-alone options

As described above, the technologies available for providing electricity in off-grid areas such as camps have changed in recent decades as many small-scale renewable-energy-based technologies have reached commercial maturity. Decentralized energy generation has emerged as a viable alternative to increasing electricity access for remote and scattered populations, and for households with low consumption levels (World Bank 2008). In providing electricity, these stand-alone products or devices provide a limited but valuable service. Technologies used include PV, small wind devices, and pico-hydro; these provide lighting, at a minimum, and usually mobile phone charging. Other energy-using services include radio, television, fans and DVDs. Generally there is a lack of information on wind flow at camp sites; in many cases where tents are used as shelters, it is advantageous to set up camps where wind speeds are low. Small wind turbines have low cut-in speeds and so could be used in some cases. The most appropriate technology, which is already in widespread use, is PV.

PV panels are also appropriate for providing power to meet institutional demands, either on their own or as part of a hybrid system with diesel. Already, PV panels are frequently being used to power vaccine refrigerators, schools, health clinics and water pumps. The technologies can pay for themselves in less than one or two years, but this will depend on the cost of the fuel they are replacing.

PV has been used widely to power health clinics and centres outside camp settings. It is often used to provide power where there has been none, and to improve the security of supply. USAID has developed a guide based on needs and experience. Table 5 provides an indication of the operational cost savings available with renewable energy. The sizing is based on a rural district health centre with a 120-bed capacity, receiving in-patient and out-patient referrals from other health clinics. This theoretical centre has a total electricity consumption of 25 kWh/day, including equipment for general service readiness, and service-specific equipment such as a small laboratory/diagnostic devices.

Table 5: A comparison of electricity supply options to provide a reliable stand-alone 25 kWh/day supply

Technology	System size	Capital ($)	Operating ($/year)	O&M assumptions
Solar PV system with batteries	6,000 W panels 100 kWh batteries	US$21,000 system US$10,000 batteries	US$1,500	1% of system cost per year (includes maintenance and component replacement, does not include security); amortized cost of replacing the batteries every eight years (12.5% of battery cost)
Wind turbine with batteries	8,750 W turbine 100 kWh batteries	US$44,000 system US$10,000 batteries	US$2,900	2% of system cost per year; amortized cost of replacing the batteries every five years
Diesel engine generator	2.5 kW	US$2,000	US$6,400	US$0.0075/kWh maintenance, US$0.67/kWh fuel ($1/litre for fuel is used), operating at 15kWh per day at 67% capacity, and replacement of engine every 10 years
Hybrid system	6,000 W panels 50 kWh batteries 2.5 kW engine	US$21,000 system US$5,000 batteries US$2,000 generator	US$1,500	1% of PV system cost per year; battery replacement every eight years; 200 hours of engine operation per year; replacement of engine every ten years
Grid extension	n/a	US$10,000+ per mile	US$900	US$0.10/kWh power

Source: Adapted from USAID, Powering Health (USAID 2009). The capital costs have been reduced from the original USAID table in line with PV cost reductions in recent years.

The electricity needs of a school are comparable to those of a small health clinic. Power supply options will depend on the size of the school and its energy needs. Table 6 shows approximate costs and reduction in operating costs for a primary school with approximately 100 students, four classrooms, lighting, electric fans, a stereo and a computer for administrative purposes (Practical Action 2012).

Table 6: A comparison of electricity supply options to provide a reliable stand-alone 5 kWh/day supply

Technology	System size	Capital ($)	Operating (US$/year)	O&M assumptions
Solar PV system with batteries	1,200 W panels 20 kWh batteries	US$4,500 system US$2,000 batteries	US$300	1% of system cost per year (includes maintenance and component replacement, does not include security); amortized cost of replacing the batteries every eight years (12.5% of battery cost)
Wind turbine with batteries	1,750 W turbine 20 kWh batteries	US$10,000 system US$2,000 batteries	US$600	2% of system cost per year; amortized cost of replacing the batteries every five years
Diesel engine generator	2.5 kW	US$2,000	US$1,400	US$0.0075/kWh maintenance, US$0.67/kWh fuel (US$1/litre for fuel is used), operating at 15kWh per day at 67% capacity, and replacement of engine every 10 years
Hybrid system	1,200 W panels 10 kWh batteries 500 W engine	US$4,500 system US$1,000 batteries US$500 generator	US$250	1% of PV system cost per year; battery replacement every eight years; 200 hours of engine operation per year; replacement of engine every ten years
Grid extension	n/a	US$10,000+ per mile	US$200	US$0.10/kWh power

Source: Adapted from USAID, Powering Health (USAID 2009). The capital costs have been reduced from the original USAID table in line with PV cost reductions in recent years.

Site-wide options

Generation technologies for supply to either a compound wide or site-wide grid include diesel, PV, wind turbines, hydropower, biomass and biogas, fuel cells or a combination, or hybrid, of these. Hybrid mini-grids can improve the reliability of supply compared to a single-technology system; however, hybrids increase the energy system's complexity. As described in the baseline, diesel generation is the most commonly used energy source thanks to its relative simplicity, low up-front investment, and the fact that many people already know how to operate and maintain a diesel generator. However, it has relatively high fuel costs, volatile fuel prices and logistical limitations. Clearly the local resource availability will determine which renewable energy technologies would be applicable in a certain context. PV is possible in most locations, whereas the potential for wind and hydro will be limited to a few locations with good wind or river resources. PV has the advantage of being both modular and mobile so can be used in settings where 'permanent structures' are prohibited. It can even be provided as a temporary measure, as packaged units with solar panels and batteries are readily available. In comparison, hydro-based projects require significant civil works and have long lead times, but they have the potential to provide power to the region beyond the timeframe of the humanitarian assistance.

A mini-grid has some permanence but in most cases could be dismantled if necessary. Any foundations required would not be much greater than what would be required for acceptable LED street lights.

A new technology that is increasingly being used in off-grid areas is the micro-grid, which supplies power to very small clusters of households or businesses via a direct current distribution. At this scale costs are modest and systems can be supplied with renewable energy only rather than a hybrid. An example of this model is supplied on page 60.

A recent study of green mini-grids for DFID concluded that this technology is appropriate for areas that are likely to remain out of reach of the interconnected grid for a few years and that have sufficient load density to make a mini-grid economically viable (as opposed to those areas where stand-alone individual or community systems would be more appropriate) (IED 2013). In theory camps meet these criteria. Operating costs are higher for PV-based systems than for hydro or biomass. Biogas digesters and biomass gasifiers are particularly promising from an economic perspective, given their high capacity factors and availability in a range of sizes, which can be matched to mini-grid loads (ESMAP 2007). However, such positive economic assessments do not generally reflect the implementation challenges, such as finding suitable supplies of sustainable feedstock for biomass generation.

All renewable energy technologies suffer from higher capital costs than a diesel engine of similar capacity. However, with reduced operating costs, renewable technologies can pay for themselves within the timeframes in which agencies typically work. For example, a PV-diesel hybrid could have cost recovery of between two and six years, depending on scale, how much the PV is contributing, and the cost of alternative fuels. The payback timeline must be calculated carefully and on a case-by-case basis. For example, in the cost-benefit analysis of PV-hybrids in the green mini-grid study for DFID, the consultants found that using economic costs only (i.e., not including fossil fuel taxes) and based on their specific assumptions, a diesel-only option was more economical (IED 2013).

Shelter, heating and cooling

Solar thermal technologies

Solar thermal technologies provide a simple, efficient and potentially cost-effective solution for heating water in camps. The technology is well established and easily available. Panels can be mounted on the ground or on roofs, where there is sufficient space, and they are relatively portable. Solar heating can also be used to heat waste in latrines (to accelerate the composting process). Where solar offsets electric heating from on-site generators, payback time is likely to be less than a year.

Solar chillers and PV-based air conditioners are also becoming more cost-effective, depending on the cost of the alternatives they would replace.

Costs of sustainable energy options

It is not possible to quote a single price for any particular sustainable energy technology since capital costs will vary according to a number of factors including specific technology type, product quality, transport costs, local policy and taxation regime (e.g. whether the technology is exempt from VAT or import taxes), and local labour costs (if required). It is therefore difficult to make clear comparisons between renewable energy technologies and the diesel, kerosene or wood that the new technologies would wholly or partially replace. That said, the sustainable energy technology will reduce operational costs.

IRENA has developed a worldwide Renewable Cost Database based on data from about 8,000 (proposed and implemented) projects, including grid and off-grid initiatives in various countries (IRENA 2013). The focus was on larger systems rather than household-scale products and analysed and compared three parameters: investment/capital cost, levelized cost of electricity generation (LCOE) and capacity factor. The study's key findings included the following:

- The levelized cost of generated electricity (LCOE) has been declining for wind, solar PV and some biomass technologies.
- Hydropower and geothermal electricity produced at good sites are the cheapest ways to generate electricity.
- Where oil-fired generation is the predominant power generation source (e.g., on islands, in off-grid areas, and in camps), a renewable solution almost always exists that would generate power at a lower cost.
- Different renewable power generation technologies can be combined in mini-grids. The complementary nature of different renewable options can stabilize power supply; despite its additional complexity, such a hybrid system can still be less costly than diesel-fired generation.
- As equipment costs decline, the share of project costs and operation and maintenance costs in the LCOE will increase unless greater efforts are made to lower such costs.
- Costs are site-specific. There is no single best-case renewable power generation technology.

A sample of costs for some common products and mini-grid solutions is provided below. The levelized cost of energy (LCOE) is also provided for the PV-diesel hybrid and diesel-only options to show a more realistic comparison. As detailed earlier, the actual levelized cost of energy will depend on the specific case, the PV contribution, battery storage and cost of fuel.

Note that where products (e.g. a solar lantern) are sold on a service or credit basis, the consumer will pay daily, weekly or monthly, and so would not see this full capital cost.

Table 7: Indicative costs for sustainable energy solutions

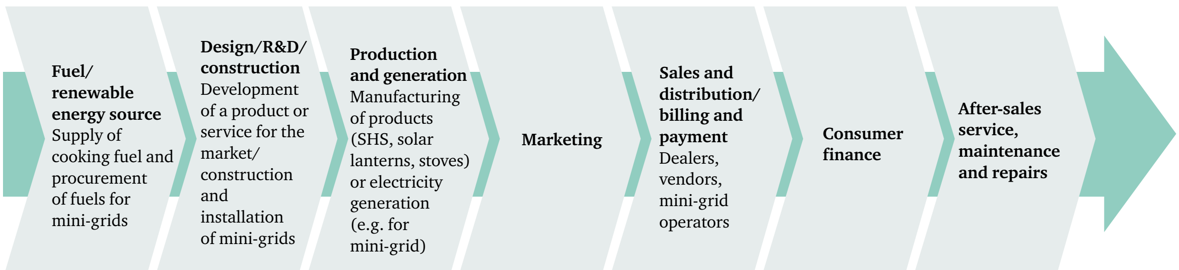
Product	Range of costs (US$)		Brief detail/notes/factors that affect costs
Cooking (household)	US$2–US$80/stove		Mud stoves can be as cheap as US$2 but if metal and imported stove costs increase to as much as US$80 (SAFE 2014)
Institutional stoves	US$100–US$400/stove		
Lighting and electricity			
Solar lanterns	US$15–US$60/lamp		0.5–3 Watt PV with internal lithium-ion battery Single LED lantern, mobile charging on some models
Pico solar	US$100–US$250/system		4–25 Watt PV with internal lithium-ion battery Plug-and-play system, 2–6 LED lights, radio, mobile charging
SHS	US$150–US$1,000/system		30–200 Watt PV with external lead-acid battery Technician installed multiroom energy system: 4–10 LED lights, mobile charging, radio, fans, TV, refrigerator (Winiecki 2014)
PV micro -grid	US$1,000/system		Supplies 30 proximate households with 2 LEDs and mobile charging and DC network
Street lighting	US$1,200–US$3,000/light		Designed to be resistant to damage, energy efficiency and lifespan of 90,000 to 120,000 hours
PV/diesel hybrid	US$6,800 –US$11,200/ kWp installed.	US$0.27 –US$0.6 /kWh electricity delivered	Capex includes PV panels and support structure, inverters, battery bank, gensets, balance of system and civil works. Does not include cost of grid (Léna 2013)
			The higher LCOE cost includes the cost of the grid. Will depend on solar resource, local fuel costs, sizing assumptions, inclusion of storage etc. (IED 2013)
Diesel only	US$400– US$1,500/ kWp	US$0.40– US$0.60 /kWh	The higher LCOE cost includes the cost of the grid. (IED 2013)

Opportunities for the private sector to help deliver sustainable energy

Energy delivery models

Energy is not just a product. Outside the camp environment there is an increasing recognition that the energy sector comprises multiple interrelated systems that collectively deliver energy supplies and appliances, using a mix of energy sources and a range of technologies (Practical Action 2012). The energy solutions described above provide access to sustainable energy, but how these solutions are delivered along the energy value chain is equally important in terms of the long-term sustainability of the energy service, i.e. who does what, and how, along the energy value chain may determine how sustainable that energy service is. The energy value chain describes the steps and roles from the fuel source all the way through to service delivery and after-sales service. An example of an energy value chain is shown in Figure 4 for off-grid energy markets (including mini-grids and stand-alone products); this could be applicable to a camp setting.

Figure 4: Off-grid energy value chain (adapted from IfC)



Source: Adapted from IfC.

The energy value chain helps to explain the various roles in the energy delivery process. In some cases only a few of these roles are filled (the current model); in some cases, the same actor could fulfil many of the roles delivering an end-to-end service, and in some cases there are numerous actors, each with a different role. Energy is delivered to users through systems that fill these roles in a number of ways. How energy is delivered is known as an energy delivery model or business model and combines infrastructure, businesses, products and services. Energy delivery models can enable energy access for the poor, such as camp residents, by varying technologies and sizes and incorporating options with regard to sales and consumer finance. Examples of energy delivery models include a grant model, a sales model, a hire-lease model, a pay-as-you-go model, and a credit model. Further details of possible models that could be appropriate for a humanitarian setting are provided later in this section.

Which energy delivery model is used during the preparedness and response phases will affect the energy delivery possibilities in the later transitional and recovery stages. A response designed for the short term is unlikely to be the most appropriate response for the longer term, such as in protracted settings. A short-term response may be unsustainable and could lead to dependency; it can also result in the acceptance of unsustainable practices, or the development of expectations for an expensive or otherwise unsustainable product.

Extent and experience of private-sector engagement in energy delivery

Other than product supply, the largest role that the private sector currently plays in camps is in fuel supply. This is mainly as fuelwood collectors and charcoal makers who sell their products to the refugees/IDPs and also to the host communities. These private operators may be camp residents or members of the host community; this varies across sites and depends on the scarcity of firewood and whether camp residents can legally access it. These activities depend on the availability of buyers who can afford to purchase the fuel, and so in turn depend on income-generating activities in camp (or negative coping strategies such as sale of food rations).

The other key areas where the private sector is engaged in energy provision result from previous energy initiatives and involve the manufacture and sale of energy-saving stoves, or the manufacture of briquettes, as well as informal micro-grids and mobile phone charging services. Training has been provided to local women in making mud or clay energy-efficient stoves that they can then sell. In some cases, as in Darfur, women entrepreneurs started businesses selling stoves, but their potential gains were limited by the fact that aid agencies were distributing stoves at the same time. Some interventions in Darfur have tried to trigger more market exchanges by helping the users to take on a consumer role (Abdelnour 2014).

In the literature there is very little mention of other energy-related activities taken on by the private sector. However, in most camps there are some entrepreneurs who use small gensets or PV modules to provide electricity or mobile phone charging services to a number of customers. For example, in Ethiopian camps entrepreneurs have invested in 30kVA to 100kVA generators and sell electricity to the camp residents and to host community members based on the number of items they install. The rates charged are the same for camp residents and members of the host communities to ensure no tensions between the groups. Other entrepreneurs may buy a genset to power their own business, e.g. an internet café or video hall.

In camps where there is some form of electricity infrastructure, businesses might be established where the electricity is diverted from the system and sold to households. In the Zaatari camp in Jordan it is reported that 'some 350 refugees with technical skills have illegally diverted electricity from the public lighting system to about 70% of the households, charging for hook-up and maintenance' (Daraghimeh 2013).

Opportunities for further engagement

There are clear opportunities for agencies and the private sector to provide the benefits of improved access to sustainable energy across camps worldwide. Outside the camp environment there is a growing belief that for the provision of energy products and services to be sustainable they are best delivered through some form of market-based mechanism. Likewise, in a camp setting there are opportunities for market-based mechanisms and the engagement of the private sector. One of the conclusions of the USAID evaluation of ICS programmes in Darfur was that the introduction of market-based principles into the stove production and distribution process should be explored (USAID 2008). An example given was that the quality of the stoves (and thus their sustainability) could be improved by charging users a minimal amount; this would give the users a vested interest in the stove's performance and could create a market for other stove services such as repairs.[12] It was noted, however, that such an approach would require all of those working in the same area to adopt the same strategy, which would require a high level of planning and coordination.

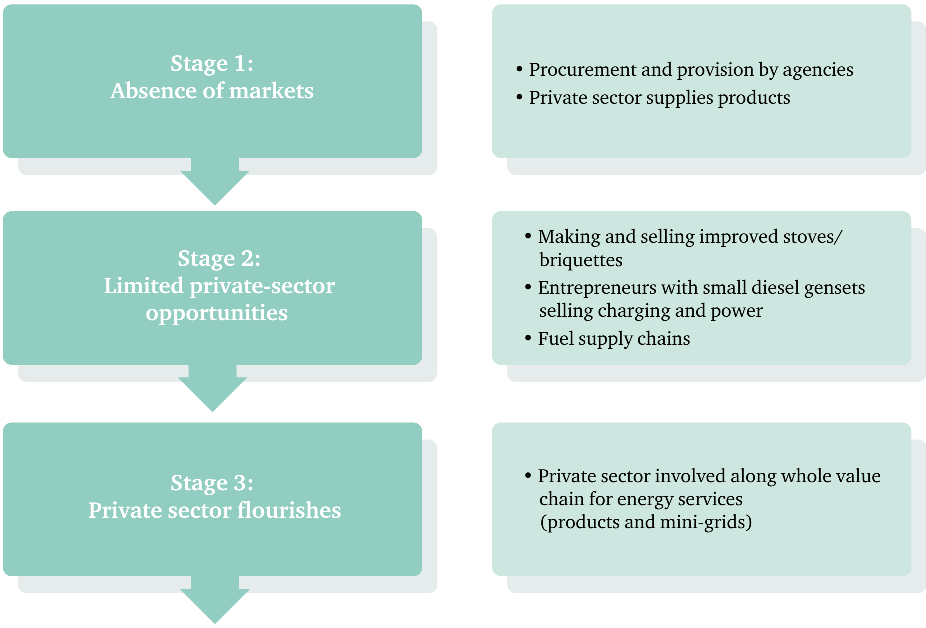
It is possible to envisage energy provision in camps following a staged approach starting with a stage (at the beginning of an emergency response) in which there is a complete absence of markets

[12] Note that it may be possible to achieve the same result if humanitarian implementers set standards for the level of performance.

and all energy services are provided through procurement and distribution by the agencies. In this stage, the private sector's role is limited to the supply of products to the agencies. As camps become established, the private sector can take on more of a role in fuel supply and some service and product delivery, as shown in Figure 5. This is the stage at which many long-established camps now find themselves; here, the private sector already plays an indispensable role in ensuring fuel supply in camps and in some small businesses. This stage could be extended to a third stage in which the private sector flourishes and is involved along the whole value chain for the provision of energy services. The greater involvement of market mechanisms in energy delivery is likely to result in more choice for the camp residents, which would mark a move away from a more paternalistic, or dependency, approach in which the residents have little or no choice. The balance between an agency-led approach and a market-led approach will be specific to each context and will depend on the actual market opportunity.

This raises a challenge for camp operators at the beginning of an emergency response (in Stage 1): How can they design systems and approaches that facilitate a transition to greater private-sector engagement without a) unnecessarily signalling to the local authorities that they anticipate a protracted situation or b) crowding out future private-sector activities through free provision of energy goods and services?

Figure 5: Possible stages of development in energy provision



Outside the energy sector, formal and informal economies flourish in most camps. A recent report on refugee economies, using data from Uganda, showed that 'a refugee community that is nationally and trans-nationally integrated, contributes in positive ways to the national economy, is economically diverse, uses and creates technology, and is far from uniformly dependent on international assistance' (Betts 2014). This shows that not only is there an appetite for business, there is also an exchange of cash.

There are specific opportunities in and around refugee and IDP camps that could be attractive to private-sector organizations. These opportunities will vary widely across camps and displaced populations. Broadly speaking, however, they include the following:

Case study 4: Introducing market mechanisms in the water and sanitation sector

There may be lessons to be learned from the water and sanitation sector of moving from 'Stage 1' to later stages. As with energy, the early stages of emergency response require immediate water, sanitation and hygiene (WASH) interventions which are normally fully subsidized and supply-driven, including water distribution, latrine construction and hygiene kit distribution. Again like energy, when applied over a long period it creates dependency and becomes unsustainable. To address this, Tearfund has piloted non-subsidized demand-driven WASH interventions during the recovery phase, and with returnee populations, in Afghanistan. Resources were invested in the promotion and marketing of household-level water and sanitation interventions. Simultaneously, people were trained to make the bio-sand filters and household latrines to meet the new demand. It is reported that this approach created sustainable livelihoods for many artisans while also addressing health issues relating to water quality and sanitation (Burt 2011).

Large concentrated markets

A camp setting, by its nature, includes a large and very dense population. Every household needs energy services, so a camp has the potential to be a large market. Of course this market potential depends on the disposable income of the population, its current energy provision, and its energy needs. Where there is some disposable income and unsatisfactory existing energy provision this could translate into a real market. Entrepreneurs in camps have identified this in some areas where they have already invested in their own electricity generation and sold electricity or mobile charging to others, for example Sirana and Digicel in Haiti.

As camps are established various needs assessments have been carried out to help agencies identify the goods and services that a particular camp would need, but these could equally provide valuable information for potential private-sector entrants, for example on their current energy provision, on population numbers and make-up. In more established camps livelihood assessments are carried out that could also provide valuable market data. Although such studies are not 'market assessments', further information-gathering of this kind could help enable future private-sector participation.

One frequently cited barrier to energy access for the poor is that it is difficult to raise awareness and set up suitable distribution channels to reach this group. In a camp setting this barrier could be mitigated somewhat by the high population densities and the existence of channels for other goods and services.

In addition to the displaced population itself there is also a more significant energy demand from the camp operators. As described earlier, this demand is spread throughout the camp (at clinics, hospitals, schools, police stations, etc.) but there is also an administration compound where there is a high concentrated demand for energy. Camp operators understand this demand, in as much as they know the number of gensets they use and the cost of the fuel consumed.

Potential for long-term customers

Despite an inclination to regard refugee crises as short-term incidents, this is often not the case. Many refugees find themselves in protracted situations (UNHCR 2006); indeed, a large number of camps have now been in place for more than ten years. Private companies need stability and a demand with a ten-year timescale would be considered sufficient to be able to build and finance a business. Moreover, where a service becomes indispensable those displaced people are likely to demand the same service when they return home. Although demand at the camp is likely to extend beyond the immediate future it is politically difficult for the camp operators to declare a long-term interest or to sign any service supply contract (such as electricity supply) for a period of more than two years.

Disposable income and/or cash and vouchers

In deciding whether to set up shop in a camp setting, private-sector actors will assess the potential for cost recovery and profitability. Some camp residents do have disposable income but this varies depending on the situation, the income-generation possibilities, the availability of credit, and agencies' policies with regard to cash and vouchers.

Refugees from Syria who come from urban environments may have more disposable income. The ACTED study on livelihoods in Zaatari. Jordan, revealed robust economic activity inside the camp. Four in five households surveyed had earned income in the past 30 days, while 16% relied solely on savings, and a small proportion (4%) had neither savings nor a source of income. The most-reported sources of income among participants were selling goods from donations inside the camp and the 'Cash for Work' programme (UNHCR, UNICEF and WFP 2014). For example the camp employs 1,500 cleaners and orderlies, for one dinar an hour. These jobs are rotated every two weeks. There is also a thriving business in electricity, land, tents and trailers (Daraghimeh 2013). In addition, money is injected into the camp economy from the cash that the refugees managed to bring with them, sent to them by relatives or from business partnerships with Jordanians.

In comparison, the majority of refugees in Kakuma, Kenya, who have been based in the camp for 20 years, have little disposable income. They have limited freedom of movement, difficulty getting permission to work, no access to land for agricultural production, and no access to credit or savings (UNHCR 2006). Despite this, there are still markets and small businesses do operate. In Dadaab, with the same restrictions, it has been estimated that the camp generates approximately US$14m per year for the host communities and US$25m per year from refugee enterprises. However, the majority of the populations still do not engage in entrepreneurial activity, with the average turnover per capita per year estimated at US$50 (De la Chaux 2014). Similarly, in camps in Nepal, refugees are prohibited from engaging in any type of paid work and from selling any goods they have produced, even within the camp. It is even reported that district governments have stopped established income-generation activities within camps following complaints from local vendors, from whom the agencies previously purchased goods (WRC 2006b).

The availability of income-generation activities may increase both the potential buying power and the energy needs of the camp population. With some increasing focus on improved livelihoods, resilience and income generation, some aid agencies and private-sector actors have introduced schemes to provide training and credit facilities to help start up income-generation activities in camps (UNHCR 2006). For example, in Uganda the Private Sector Foundation is offering training and credit to IDPs to help them establish IGAs. Access to credit also varies in camps according to the local authority regulations. As mentioned above, credit and savings services are not made available to refugees in Kenya.

A promising and growing trend is the use of cash-based programmes, which give camp residents greater autonomy on how money is spent and could encourage the development of new income-generation activities. There is growing acceptance of cash interventions, which are perceived to be feasible and effective in such settings; these have increased substantially over the past decade (Harvey 2007; Harvey 2010). There are two major advantages of cash assistance: it can be cost-effective and it provides a great deal of flexibility for beneficiaries in deciding when and how to use funds (Harvey 2007). There are various options that include direct cash transfers, cash for work, conditional cash transfers, pre-charged credit cards or voucher programmes used for a particular type or bundle of goods. WFP is increasing its use of cash vouchers, and UNHCR is more frequently using a pre-charged credit card. In the future, camp residents may be provided with one card each for food and NFI components. Depending on the priorities of the refugees or IDPs, this could increase demand for further energy services.

High cost of existing solutions and negative coping strategies

There is a clear opportunity to improve the current baseline situation, which results in high costs and/or negative coping strategies for the displaced population. Where people pay for their energy, this can be a significant and regular payment. The alternative sustainable energy solution, if paid for as a daily, weekly, or monthly service, can be less expensive. There are examples of energy delivery models serving the Bottom of the Pyramid (BoP) where demand is proven and the users are saving on their regular costs. In Tanzania the Off Grid Electric model costs consumers US$0.19 per day for an entry-level service (two bright lights and a phone charger). This replaces typical kerosene costs of about US$0.25 per day. Energy services from Azuri, operating in sub-Saharan African countries, cost about US$1.50 for one week's activation; this is estimated to be less than the cost of kerosene and phone charging. An assessment of actual household energy costs in a particular camp would provide a better idea of what might be possible in terms of offsetting.

Reliable institutional customers

In contrast to the camp population, the institutional customers at any one camp are a few larger agencies who have responsibility for the camp management, or the specific responsibility for the health facilities or other services. These agencies tend to be large and have a dedicated budget currently used on fuel for their existing gensets. As a result these could be considered reliable customers.

Innovations in energy delivery and applicability to humanitarian settings

One of the key barriers to access to energy is the relatively high upfront cost of the technologies, which are unaffordable to households that budget on a daily basis. This is equally true within or outside a camp. A number of energy enterprises are now addressing this key barrier in a number of ways, including selling low-cost entry-level energy products, offering energy as a service on a pay-as-you-go (PAYG) basis, leasing products, and offering consumers micro-credit or central charging services. Each of these models has the potential to operate in a camp setting and provide (lighting and mobile charging) energy at an affordable price that is competitive with current costs for kerosene and mobile charging.

Various energy supply models can be used to meet the energy demands of camp institutions and management in addition to just selling energy solutions or technologies. These include a build contract or BOO (build-own-operate) contract, which includes on-going maintenance, or a service contract paid for by energy unit.

The following is a summary of some of these models, although this is not intended to be a comprehensive list. Further research would be required on the applicability to camp settings.

Low-cost entry-level energy products

Low cost small-scale technologies (approximately US$10) are distributed through small local dealer networks to increase market penetration. Products are sold outright. Barefoot Power and Sunny Money use this model, with Sunny Money accessing markets via school teachers and then agents who can carry out maintenance and up-sell to larger products. Many improved cookstoves are already low-cost, particularly locally made mud-stoves, and some existing commercial companies have reduced costs further through efficiencies in labour. For example, Tizazu in Ethiopia and Toyola in Ghana have reduced costs by keeping the design very simple and using local artisans (IFC 2012b).

The advantages of this model are that there is little risk associated with entering a new market (such as a camp), but affordability may still be an issue for large parts of the camp population. The availability of working capital to expand into a new market may limit the potential of this model. Only with high-volume sales would a business become viable.

Pay-as-you-go (PAYG) business models (hire-purchase and service)

Under a PAYG model, the customer has a small solar lighting and mobile charging system installed in his or her home and pays for the service through daily, weekly or monthly payments via mobile money or scratch cards. A proof of payment code is put into the device to activate it; in the event of non-payment, the system is demobilized. Key objectives for PAYG companies are to deliver energy at a price that is competitive with alternatives, that is paid for at similar intervals to alternatives, and that provides a return for the business. The financing terms and unit cost are often designed to be cheaper than existing expenditure. PAYG businesses can be structured either according to product financing model – where the customer ultimately owns the system after a certain number of payments – or as a service where the customer continues to pre-pay for the electricity. Although the current figure of customers is in the hundreds of thousands, it is estimated that in the next five years, at least three million PAYG solar systems will be sold globally (Winiecki 2014). Examples of PAYG solar companies include Angaza Design (Kenya, Tanzania), divi Power (Namibia, Kenya, Ghana, Somaliland, Peru), M-KOPA Solar (Kenya, Uganda), Azuri Technologies (East and West Africa), Mobisol (Kenya, Rwanda, Tanzania), Off Grid Electric (Tanzania) and Simpa Networks (India).

This model could be used in a humanitarian setting as it works well with poor customers with uncertain incomes, because of its flexibility, user-defined payments, and the ability to forgo payment (and therefore usage) without facing a penalty. On the other hand it relies on the customer staying around to make payments over a 12–18-month period and the additional technology to allow for the PAYG system increases the cost of the product marginally. The profitability of some of these models is predicated on future up-scaling of the energy services, which may make them less applicable for camps.

PAYG has been made possible through advances in technology that mean it is easier to design and programme micro-controllers for solar system; the increasing network coverage and uptake of mobile phones; and mobile money services that enable micro-payments to be made and processed. Which PAYG technology will be most appropriate depends on the popularity of mobile money services and the extent of a reliable mobile network in the area. Where mobile money services are not as prevalent it is still possible to validate the code with a dedicated agent.

In a camp setting, a PAYG company would need to identify and train a network of agents who would generate sales and install and deliver the products. Where mobile money is not established they would also be able to collect cash and process the proof-of-payment with the PAYG company via SMS.

Consumer credit

The availability of credit can enable customers to spread out payments, which may make them easier for the customer to manage. This can be done through the credit offered either by the dealer (similar to PAYG services) or by a third party, e.g. a micro-finance organization that is experienced in working in the target area. One of the most successful examples of this model is Bangladesh's IDCOL solar home system programme, which has installed more than three million systems since 2003. IDCOL, a Bangladeshi government-owned financing company, works with approximately 40 partner organizations (PO) that sell, install, guarantee and maintain the SHS systems. The POs can extend micro-credit to the consumers in order to sell the systems; their own technicians install and guarantee the system, and maintenance can be performed when collecting payment. The household can choose to buy the SHS with either cash or credit. In the case of credit, the households are required to pay a minimum of 10% of the cost of SHS as a down payment at the time of signing a contract with a PO. The PO thereby extends a loan to the household and enters a sales agreement for complete payment within three to five years, with equal monthly instalments. As with the PAYG model, there are significant risks for the energy company in terms of non-payment and theft, and the model relies on the customer's staying put for an extended period of time.

Cookstove companies have also experimented with consumer financing to increase their reach among the poorest. For example, Ugastove in Uganda makes its US$7 improved wood and charcoal cookstoves more accessible by allowing flexible repayment terms that correspond to the cash saved on charcoal. On this basis it is able to expand into more remote parts of Uganda and neighbouring countries. Ghana's Toyola also offers customers the option to buy on credit and to pay back the loan over two months using the money saved on charcoal, with many using a 'Toyola Money Box' to keep their savings. Annual saving on charcoal of around US$27 is significant and cost is recovered within three or four months. Toyola finds that that there is a repayment rate of about 99%. The funds for this credit plan come from concessional loans and could also come from carbon finance (IFC 2012b).

In 2014 Potential Energy launched a revolving loan fund (RLF) initially structured to offer 2,500 improved stoves on credit to resettled populations in North Darfur. Potential Energy worked with a local organization and a number of community-based organizations. The customers pay 25% of the costs as a down payment and then make the remaining payment in three instalments over three months. Although there is demand for the stoves, challenges have been identified in repayments and in rising costs of operating in the area. This has meant that at the initial price point, the fund will not be revolving. Repayment rates have been mixed, for several reasons: road closures; the difficulty of collecting payments in areas of conflict; and client inability or unwillingness to pay. Potential Energy is looking to address these challenges in the next phase by increasing the price and looking at incentive options for the payment collection agents.

In Sudan the high upfront cost of LPG cylinders and appliances was seen as the main constraint on LPG uptake. Private LPG companies considered it too risky to extend credit to poor households. The LPG companies were convinced that profits were based on selling the gas, not on the cylinders or appliances. Now they provide the cylinders on credit to the Women's Development Associations who use a revolving fund system, based on traditional practices of women's savings groups, in order to access the credit for households' access to LPG appliances.

Providing and managing credit can be complex and costly. Although the additional costs of credit are covered in the repayments, this means that to keep the costs affordable for poor customers, margins are very tight. As with other models, only with high volumes does the business really become viable.

Low-load micro-grids

In this model an energy enterprise builds, owns and operates a mini- or micro-grid that sells energy to individual households or businesses, much as some entrepreneurs already do in camps with diesel gensets. The customer pays a connection fee and then a weekly fee, which is collected by designated collectors who visit each week. In the simplest case, fees are based on the number of appliances in the household. As with the PAYG model, the aim is to provide energy at a cost similar to alternatives and to run a commercially viable business. With emerging direct current technologies this has promising potential to meet demands in camps. The model could provide affordable and appropriate energy to households (and businesses) in a camp, and being modular, such micro-grids can be scaled up. As with other models, however, this approach – which has a predicted payback of 2.5 years – relies on long-term customers.

Case study 5: Micro-grids in India

Mera Gao, in India, operates solar-powered micro-grids which supply clusters of between 16 and 32 houses with two LED lights and a mobile phone charger for a weekly fee of INR 25 (~US$0.4). In the Mera Gao model the number of hours is limited to 7 hours for the LEDs and the system relies on the community policing itself regarding abuse of the system. If there is abuse on the system, and a particular household is drawing too much power, it switches off all the households on that line until the abuse stops. Following default in payment the household is disconnected. To assess demand Mera Gao holds an engagement meeting in a village to see how many people are interested in signing up for the lighting service. A similar process would be possible in a camp setting and local people could be trained.

Since the services provided are small the actual up-front capital cost is modest with just a 240 Wp PV panel, associated batteries and connections for the 32 houses at a cost of approximately US$900.

Central energy service point/kiosk

This model already operates in camps, to an extent: entrepreneurs who have purchased a diesel generator or PV panel charge residents for mobile phone charging services. However, this approach can be extended beyond phone charging to charging other services such as batteries and battery-run lights. At the same time, the service point can offer additional energy services such as cooling, internet and communication as well as being a market stall. Beyond that the service point can rent out and sell energy products as well as offering PAYG services. The model can be based on a franchise model where the micro-entrepreneur is licensed. Examples include Sirana operating in Haiti charging batteries from PV and grid; Solar Kiosk, a modular PV-powered kiosk operating in sub-Saharan Africa; Nuru Energy, which provides pedal-based power in Rwanda; and Digicel, which provides services in camps in Haiti. Advantages of this model are that customers pay only when and for what they can afford and it allows them to ‘up-scale’ at any point. Jobs are created for local agents in the camp. Again, owing to the set-up costs, such businesses only become viable with a larger number of service points.

Build, own and operate/energy service contracts

It is technically possible for agencies to outsource their energy provision to a third party rather than procuring and operating the diesel gensets themselves. Contracts can be structured such that the agency pays for each unit of energy (kWh) delivered to the compound and all the risks associated with equipment procurement, maintenance and fuel stay with the contractor. Another option could be that the contractor takes responsibility for the equipment supply and maintenance but the supply and cost of the fuel remain with the agency. The most appropriate contract will depend on the existing arrangements for fuel and the comfort level of both parties. The allocation of risk between the partners will be reflected in the final unit price.

Energy service contracts would be possible under the business-as-usual case for the compound/centralized power requirements, but they would become more attractive if agencies are looking to diversify their energy sources. To meet a pre-determined demand, a contractor could propose a PV-diesel hybrid solution to reduce the overall unit cost of electricity over a number of years. The advantages to the agency are that they outsource the skills they do not have (e.g. PV equipment procurement and the skills to maintain it) to a contractor with specialized knowledge, and energy costs are reduced over time. The contractor can be incentivized to invest in renewable energy and in more efficient generators through the pricing signals in the contract. For example, if there is a fixed cost per unit of energy it is in the interest of the contractor to reduce operation costs as much as possible. Additional savings can be passed on to the agency at a predetermined point once the contractor has covered the capital costs. The disadvantage of such a contract is that any energy service contractor would need a contract covering a number of years to make the investment worthwhile.

Such a model could also allow for the contractor to extend the grid to the displaced population, if the market opportunity exists. The institutional demand could act as an anchor load and any supply to the camp population could be an additional income source for the contractor if considered viable.

Challenges and Risks to the Provision of Sustainable Energy Within Displaced Populations (Outside the Humanitarian System)

This section provides an overview of some of the challenges and risks of providing sustainable energy in camps. It outlines some of the issues for the agencies (with more detail provided in the companion paper on policy and practice) and summarizes the responses of private-sector enterprises with regard to what they see as the key issues in serving displaced populations.

Agency challenges to the provision of sustainable energy

With high and increasing refugee and IDP populations, such as that produced by the Syrian civil war and climate change, there are increasing demands on services offered by the agencies and host governments. Agencies must prioritize needs with limited funding. The lack of funding inevitably results in an inability to meet demand. Energy, without its own champion, can become a victim of this. This is further compounded as there is no dedicated expertise in energy, and a lack of capacity and awareness of alternatives to the 'standard' options of diesel water pumping or diesel gensets. In addition, the host government's policy towards refugees/IDPs has a significant impact on the ability of the agencies to fund and build long-term infrastructure for 'temporary camps' while the short-term funding cycles of the agencies constrain their ability to fund the higher up-front capital costs associated with sustainable energy.

Private-sector risks and challenges

According to the enterprises interviewed, the risks and challenges of operating in a camp are not insignificant. The private sector needs stability to invest and there are many other more commercial, easier opportunities available – i.e. large markets with non-electrified populations which are easier to access, have clearer sources of income, are more static, entail less risk and would not need any adjustments to existing business models. Specific risks identified included: the risk of crowding out from grant products, risks associated with operating in fragile states with poor security, the uncertainty that the camp will remain for long enough to recover costs, the lack of disposable income of the customers and issues relating to trust and high likelihood of theft. In addition, the policy environment will impact on operation and because each camp is different there is a limit to scaling up.

A better understanding of the risks and the need for any incentives to facilitate market-based mechanisms is needed prior to designing a pilot project which encourages private-sector models.

Although there are clear opportunities available from supplying energy services in camps, there are also significant challenges, which can restrict further work by agencies or deter investment from the private sector. Many of the difficulties relating to energy supply described below can become more of an issue when people are displaced for long periods of time.

Agency challenges

The challenges relating to agency-provided energy are dealt with in more detail in the companion paper on policy and practice. In addition, the SAFE reference group has identified many of these issues. Some of these challenges are summarized below:

Government approach to refugees and renewable energy

The host government's approach to refugees has a significant impact on agencies' ability to fund and build long-term infrastructure for temporary camps. Despite experience to the contrary, camps are established as 'temporary' features. In practical terms this means that in some cases permanent structures – or structures that may be perceived as permanent – cannot be built. This can preclude a number of standard sustainable-energy-related options such as more energy-efficient buildings, electricity infrastructure such as a mini-grid, concrete-based biogas systems or foundations. This is true in Kenya although the Dadaab refugee camp has existed for over 20 years. In other cases where an agency is seen to invest in longer-term infrastructure it signals to the host government that it intends to stay beyond the initial 'temporary' stage.

The host government's policy relating to renewable energy, and its regulation of the electricity sector, will also affect what is possible in a camp. For example, in Kenya any power generation over 500 kW should be operated by Kenpower, which makes it difficult to attempt new approaches.

Short funding cycles and inadequate funds

With high and rising numbers of refugees and IDP populations, such as that produced by the Syrian civil war and climate change, there are increasing demands on the services offered by the agencies and host governments. Agencies must prioritize needs with limited funding. The lack of funding can result in an inability to meet demand. For example, the production of stoves from the GIZ Stoves Production Unit (SPU) in Dadaab and outsourced stoves cannot keep up with the demand. The production of improved stoves in Dadaab is donor-funded through UNHCR and the number to be produced and distributed depends on funds provided. In 2011 they were producing approximately 22,000 per year, which was just adequate to cover the annual new influx of refugees and host community demand. However, GIZ noted that the rate of coverage would continue to decline since there was a cumulative loss due to depreciation of the stoves. The Maendeleo Portable Stoves last between three and four years. Based on a life span of four years, it is estimated that 25,000 stoves require replacement annually (GIZ 2011).

For camp operations, sustainable energy has higher up-front capital costs compared to traditional options, which means that it is difficult to fund unless the agency is also reviewing the longer-term operational costs. The status quo is to continue to buy cheap over-sized diesel engines despite high fuel costs and potentially expensive maintenance. In addition, funding cycles for agencies often cover a period of up to a maximum of two years, which makes it very difficult to fund anything with a payback beyond that.

Lack of recognition of energy within the humanitarian system

Energy is not currently identified as an issue in its own right within the humanitarian system and therefore is not afforded priority; instead it is normally considered as a sub-subject under an existing cluster, normally the Shelter Cluster. Without this recognition, energy does not benefit from existing mechanisms where coordination and budgets are allocated according to cluster (e.g. WASH, health, education or shelter) or cross-cutting issues such as gender. Energy is also not included as a line item in the Consolidated Appeals Process (CAP) and Flash Appeals. This limits funding through the United Nations Office for Coordination of Humanitarian Affairs (OCHA), which provides humanitarian support and funding for programmatic interventions. The SAFE Steering Committee is currently reviewing the most appropriate option for the inclusion of energy in the humanitarian system.

Lack of capacity and expertise

In a humanitarian setting, energy is a cross-sectoral issue with no agency or cluster taking overall responsibility for energy issues. Instead, those working in waste and those working in water look at energy separately, and again each of those responsible for shelter, health or administration looks at the energy options independently. Since energy on its own is not a priority there is no dedicated expertise in energy and a lack of capacity and awareness of alternatives to the 'standard' options of diesel water pumping or diesel gensets. Although expensive to run, the existing options are reliable and well understood, and the maintenance skills are readily available; thus there is resistance to change. The SAFE Steering Committee has recommended that training and capacity building be a core component of any SAFE project, and has conducted training and developed tools for implementers.

Poor infrastructure

In its review of stoves in Dadaab, GIZ also stated that the bad roads in northeastern Kenya were one of the challenges to implementation. The roads are impassable when it rains, making it very difficult to transport raw material, especially clay soil (GIZ 2011).

Unintended consequences

Despite the best intentions there are cases where there are unintended consequences from well-meaning energy initiatives. This includes the sale of energy products and fuel to purchase other items. Not only does this leave the seller without the 'improved solution', it also devalues the product by selling it at significantly below its market value.

Private-sector risks and challenges

As described above, there are a number of potential opportunities for private companies to engage in energy services in a camp setting. However, the motivation for any private company to enter a new market is clearly that the benefits outweigh the risks – whether the motivation is immediate profit, future profit or a social return. According to those interviewed the risks and challenges are not insignificant. Small energy enterprises were asked why they were not already engaged in camp environments. One key reason provided was that although they may have considered it, there are so many other more commercial, easier opportunities available, i.e., as noted above, large markets with non-electrified populations that are potentially easier to access, have clearer sources of income, are more static, entail less risk, and would not require any adjustments to the enterprises' business models. The private sector needs stability to invest. A number of specific risks are listed below.

Specific risks related to camps

Crowding out

One of the risks most frequently cited by the interviewees relating to working in a camp was the risk of being crowded out by grant products. Financiers will question the market if products are being handed out in the same camp. Not only will this undermine the market for energy services, it can also lead to market spoilage. It may be possible to mitigate some of this risk by distributing grant products only to the most vulnerable in a camp; however, a potential market entrant may still see this as a problem.

Fragile states and poor security

Many camps are established in fragile states or in areas of poor security. There is therefore an inherent risk in working in such areas. This will compound issues relating to access to finance for the business.

Lack of affordability

For a sustainable business model, whether selling energy products or services, it is of course important that the target population can afford the service. In some camps there is a real risk that the population lacks any form of income or funds to enable it to pay for energy. This is particularly the case in camps that have been in existence for many years and where local regulations limit credit availability and income-generation activities. For example, cost recovery may not be possible on the Somali border but is more likely in Syria, Jordan and Gaza.

Customer trust and theft

Any business model that includes service payments over a period of time must put trust in the customer, in particular the customer's ability to pay and stay in one place; the likelihood of theft must also be low. Without assurances that specific customers remain static and can be identified (without an address or geotag), the company takes on a risk when it installs equipment.

Uncertainty of permanence of the market

Although many IDP and refugee camps are around for years it is politically difficult to declare an intention to stay for an extended period of time. Therefore for any business wanting to establish itself in a camp, it may be difficult to access finance since it is not possible to guarantee the market beyond, say, a two-year period. This may be a particular problem for a business supplying energy to meet institutional demands. However, for individual customers where the business model is able to become profitable on shorter timeframes this may not be considered a significant risk (for example, where payback on pico-solar under a PAYG scheme is expected to be between 12 and 18 months).

Policy environment

To those outside the camp it may not be clear what policies and regulations govern the operation of private-sector actors in the camps. For example, it may be difficult to ascertain the extent to which they are encouraged to operate there. In many cases, the private company would look to identify appropriate agents within the camp, which could be a challenge.

Limits to scaling up

Although all the camp settings worldwide represent a potentially enormous market, there are clear limits to scaling up any model owing to the difficulties of replicating any model in two different camps. Camps are at different development stages and social, economic, cultural, regulatory and environmental contexts vary widely; what works in one camp will not necessarily work in another setting. For example, according to UNHCR, energy needs identified in Bangladeshi camps relate only to lighting at night and reducing rubbish dumping, and there is not enough income to expect more. However, Syrian refugees in Jordan initially want a concrete floor, phone and lights, a fridge and then a fan and TV. In Ethiopia the situation is similar, with needs identified as light, phones, fridges, TV, DVDs and internet (McCallion, 2014).

Other common challenges to energy business operation

There is no literature relating to private-sector energy enterprises in a camp setting (with the exception of stove manufacturers as part of a funded energy initiative). However, there is extensive development literature on barriers to the delivery of modern energy services to the poor. One of the key barriers – low population densities – does not relate to camp situations, but the majority of the other challenges cited hold true for energy access for camp populations. A systematic review of the major barriers to modern energy services for the poor (but not targeting refugees and IDPs) found consistent and strong evidence relating to economic and technical barriers but weak evidence relating to political and cultural barriers, although the latter were frequently cited (Watson 2012). Some common challenges that would also apply in a camp setting are outlined below.

Low projected level of energy consumption

Although camps provide a concentrated market, there may be a low projected level of energy consumption, which presents a significant commercial challenge to energy businesses. This is partly due to limited incomes but also due to expectations. Needs and expectations vary enormously across different groups and countries.

Attitude and lack of awareness

There is a concern that many camp residents have become over-reliant on aid, particularly in protracted settings, where they have been provided with the minimum to survive. Although understandable, this mindset is difficult to change. Moreover, camp residents may display caution about new technologies and resistance to change.

A lack of consumer awareness or public knowledge on energy options is a barrier to the uptake of alternative energy solutions. Although there may be knowledge of a product, such as an energy-saving stove or PV light, there is not necessarily a clear understanding of its benefits and the associated change in service and saved money or time over its lifetime.

Previous initiatives that have failed can have a negative impact on the potential market for related products or services. Barriers relating to hardware create direct problems for the users of specific products and indirect problems by reducing confidence in all related products; this can then affect the market (and the SMEs working in it) for all products. If there is little or no quality control – in terms of standards for manufacturing, installation and maintenance – then there is a danger that low-quality goods will be imported.

Lack of market knowledge and capacity

There is limited information available to potential energy enterprises about the potential markets in camps. To those outside the humanitarian sector there is little knowledge of how camps work, how to access information, or what displaced people want or need.

Access to finance for potential businesses

In energy access more generally, one of the main challenges facing energy entrepreneurs and SMEs is accessing finance to start or grow their businesses. This is likely to be especially the case where the proposed model or the market, such as a camp, is untried. Energy technologies are maturing, the market for related products and services is expanding rapidly, and new business models are being tried. However, few financial institutions are active in this area, although there are a growing number of social investors. Many energy projects are financed by these social investors or by donors.

Commercial financing institutions finance large-scale, better-understood energy projects but are not active in the financing of small-scale ones. This is partly due to a lack of understanding of the market, the small scale, and a perception that energy projects involve high risk and high transaction costs, with low returns. Some financial institutions believe that the SMEs working in the sector, and the related technologies, are unreliable and lack long-term viability; hence they are reluctant to finance businesses or projects.

Exchange rate risks

In all business models where payments are in local currency but products are imported, exchange rate changes can reduce profit margins. This is all the more critical when serving poor customers, where payments are small, products relatively cheap and the margins already low.

Conditions required by the private sector to invest

Although the 'energy' private sector could be interested in operating in the camps, bearing in mind the risks, **there is not a compelling enough reason to establish there**. A better understanding of the risks and the need for any incentives to facilitate market-based mechanisms is needed prior to designing a pilot project.

A number of mechanisms are possible that would 'de-risk' the opportunity for energy enterprises in camps. Which approach is most suitable will depend on the business models proposed, on the overall objective of the pilots, and on the ability of the funders to finance the private sector directly. Potential mechanisms include the following:

- Limited start-up funding to facilitate research, data collection, market mapping and/or initial establishment and training of a network of agents;
- Provision of working capital to cover the costs of the products aimed for the camp market;
- Grant funding to cover the costs of establishing a PAYG pilot;
- Concessional funding to cover some capital costs;
- PAYG services paid for by agency (directly or indirectly through consumers);
- Long-term contract with an energy service company;
- Guarantees to pay long-term energy costs; and
- Provision of clarity on regulations for private-sector actors working in camps and on tax and duty regimes with reference to camps.

Annex A: List of Interviewees/Consultations

Ernest Achtell	DFID Kenya
Katherine Arnold	GACC
Joe Attwood	NRC
Dan Ayliffe	DFID Bangladesh
Ivan Blazevic	UNEP
Will Blyth	Chatham House
Oli Brown	Chatham House
Sarah Butler-Sloss	Ashden Awards
Simon Collings	GVEP
Ruth Dobson	Solar Aid/Sunny Money
Amare Gebre Egziabher	UNHCR
Megan Gerrard	WRC
Ben Good	GVEP
Sameer Hajee	Nuru Energy
Corinne Hart	GACC
Michelle Kreger	Potential Energy
Razi Latif	DFID
Sarah Lester	DFID
Paul McCallion	UNHCR
Clare Manning	GlaxoSmithKline
Charlie Miller	Solar Aid/Sunny Money
Andrew Morton	UNEP
Chris Porter	DFID Kenya
Kieran Reynolds	Azuri Technologies
Howard Rush	IDS, University of Sussex
Brian Shaad	Mao Guru Energy
Chhavi Sharma	Ashden Awards
Virinder Sharma	DFID Kenya
Graham Smith	Off Grid Electric
Andreas Spiess	Solar Kiosk
Caroline Taylor	Azuri Technologies
Mattia Vianello	Practical Action Consulting
Alistair Wray	DFID
Tim Young	Practical Action

Annex B: Literature Review Methodology

A broad range and combination of search terms were used based on the expected impacts of sustainable energy on displaced and host populations. An initial list of search terms was prepared which was then continually refined during the pilot search to ensure that the search picked up any document relating to the subject area. As far as possible, the terms allow for variants of word beginnings and endings. Some of the terms have meanings outside the energy sector. For example, the pilot test search revealed that the terms 'light*' and 'illuminat*' resulted in many irrelevant hits. The full set of database search terms is provided at the end of this annex.

The search terms were applied to titles and abstracts for all the academic literature databases used. For the grey literature each of the websites operated differently so specific sets of search terms were used for each. In each case the search was first carried out for titles and then for page content. A full set of search terms for each grey literature database is available on request. Snowballing was used in addition to the initial search.

The limits to the search were set for all publications since 2006 and only English-language publications.

Standard databases were used which include publications from most international energy journals such as *Energy Policy*, *Energy for Sustainable Development* and *IEEE Proceedings*. These included: Web of Science, Scopus and Chatham House. The humanitarian journals were not listed in the databases, so were searched separately. These included: *Journal of Humanitarian Assistance*, *Humanitarian Exchange Magazine*, *Journal of Humanitarian Logistics and Supply Chain Management*. Grey literature was searched for from international organizations and agencies involved in humanitarian crises. This included UNHCR, WFP, WHO, UNICEF, FAO, Care International, Oxfam, Norwegian Refugee Council, Danish Refugee Council, World Vision, Mercy Corps, Plan International, Save the Children, Women's Refugee Commission, International Organization for Migration, USAID, Islamic Relief, ACTED and UNRWA. In addition Google search brought up a number of other NGO websites working in the area.

The titles and abstracts of academic material meeting the criteria were entered into an internet-based reference database, Mendeley. 2,270 papers were identified from the databases covering all the issues, once duplications had been removed. Each of these papers was then screened for relevance based on the title and abstract. In the grey literature a further few thousand documents and web pages were identified which were screened by title and abstract where possible and by search result where not. This identified 47 relevant articles from the academic literature and hundreds from grey sources for full text review. A detailed review of the quality and relevance of these articles showed that only a few papers linked sustainable energy initiatives in displaced population camps to monitored benefits although more than a hundred make the link. The majority of these focus on improved or alternative energy stoves. There are many papers that make the link between sustainable energy and the environment and socio-economic benefits, but few follow this up with evidence. There are also many reports and links that detail the impact of traditional energy supply on the livelihoods and environment of the camps.

Search terms used for database searches

Limits:

- Dates: 2005 – current
- Fields: Title, Abstract and Keyword
- Publication Types: ALL
- Language: ALL

Table 8: Search terms and results from literature review

	Search terms	Results
Group 1	displaced person*	598
	displaced population*	205
	displaced people*	286
	IDPs	806
	IDP	937
	refugee*	9,010
	evacuee*	816
	dislocated civilian*	0
	stateless person*	33
	stateless people*	22
	asylum seeker*	1,726
	displaced camp*	543
	post conflict	1,865
	emergency settlement*	2
	humanitarian emergency setting*	4
	humanitarian setting*	40
	post emergency	125
	post emergencies	125
	military camp*	409
	Total	**14,405**
Group 2	renewable energy	41,237
	sustainable energy	4,121
	alternat* energy source*	1,822
	natural resource*	45,446
	FES	4,593
	stove*	6,029
	cooker*	2,699
	ICS	11,444
	cookstove*	220
	ethanol	108,061
	biogas	9,743
	briquette*	1,168
	briquet*	495
	photovoltaic	49,527

	Search terms	Results
Group 2	solar power	16,527
	solar lantern*	31
	solar light*	2,316
	solar lamp*	19
	solar energy	35,781
	solar thermal energy	736
	biomass energy	131,648
	PV	33,746
	energy solution*	1,479
	energy policy	15,543
	bio fuel*	1,721
	bio energy	2,544
	clean energy	3,768
	energy access	234
	Total	**334,123**
Group 3 (a)	environment	1,025,552
	deforestation	9,279
	desertification	2,813
	emission*	496,267
	forestry	64,650
	fuel wood	28
	fuelwood	1,013
	firewood	1,034
	fire wood	94
	charcoal	11,862
	kerosene	5,523
	diesel	51,797
	CO_2e	371
	CO_2	126,146
	Total	**1,691,863**
Group 3 (b)	health	1,525,312
	indoor air pollution	8,322
	respiratory illness*	2,325
	asthma	78,521
	burn*	107,808
	Total	**1,686,908**
Group 3 (c)	security	249,621
	gender based violence	597
	GBV	347
	rape*	14,955
	attack*	155,649
	domestic violence	8,039
	sexual violence	2,441
	sexual harassment	1,668
	Total	**387,124**

	Search terms	Results
Group 3 (d)	enterprise	137,263
	income generation	726
	livelihood	10,593
	employment	82,346
	unemployment	16,760
	small business	4,684
	microcredit	503
	subsistence	5,417
	private sector	18,241
	empowerment	15,298
	Total	**276,646**

Acronyms

BOO	Build, Own, Operate
BoP	Bottom of Pyramid
CIDA	Canadian International Development Agency
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DRC	Danish Refugee Council
ECHO	European Commission's Humanitarian Aid and Civil Protection department
ESDC	UN Logistic base's Engineering Standardization and Design Centre
FES	Fuel-Efficient Stove. Throughout this report the term improved cookstove is used.
FGD	Focus Group Discussion
GAalCC	Global Alliance for Clean Cookstoves
GBV	Gender-Based Violence
HAP	Household air pollution
IASC	Inter-Agency Standing Committee for humanitarian assistance
ICS	Improved Cookstove
ICT	Information and Communication Technology
IDP	Internally Displaced Person
IED	Institute of Economic Development
IGA	Income-generating activities
IOM	International Organization for Migration
ISSB	Interlocking Soil Stabilized Block
kWh	Kilowatt hours
LCOE	Levelized cost of electricity
LED	Light emitting diode
LPG	Liquefied petroleum gas
NFI	Non-food item
NGO	Non-governmental organization
PAYG	Pay as you go
PV	Photovoltaic
SAFE	Safe Access to Fuel and Energy
SGBV	Sexual Gender-Based Violence
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNIFIL	United Nations Interim Force In Lebanon
USAID	United States Agency for International Development
WASH	Water, sanitation and health
WFP	World Food Programme
WRC	Women's Refugee Commission

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About the Author

Rebecca Gunning is an independent sustainable energy consultant focusing on energy access and energy in development. She previously worked for IT Power on renewable energy issues in Europe, sub-Saharan Africa and Asia. She is a Chartered Mechanical Engineer and sits on the Renewable Energy Power Committee of the UK's Institute of Mechanical Engineers. She has an MSc in Environmental Technology from Imperial College and a BSc in Engineering from the University of Durham.

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The Royal Institute of International Affairs
Chatham House
10 St James's Square, London SW1Y 4LE
T +44 (0)20 7957 5700 F +44 (0)20 7957 5710
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