



Prices, Products and Priorities

Meeting Refugees' Energy Needs in Burkina Faso and Kenya

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Contents

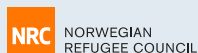
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About the Moving Energy Initiative

The Moving Energy Initiative (MEI) is working to achieve access to clean, affordable and reliable energy among displaced populations by:

- **Working with humanitarian agencies and donors** to change policies and practices, drawing on evidence from practical projects;
- **Working with the private sector** to design and implement innovative market-based solutions;
- **Improving the evidence base** through original research and the demonstration of new approaches tried and tested in camps and host communities; and
- **Cooperating with host governments and national NGOs** to improve energy security among both local and refugee communities.

The MEI is a collaboration between Energy 4 Impact, Chatham House, Practical Action, the Norwegian Refugee Council (NRC) and the Office of the United Nations High Commissioner for Refugees (UNHCR), with funding from the UK Department for International Development (DFID).



Preface

The fundamental importance of energy access for reducing poverty is highlighted by the UN Sustainable Development Goal 7, namely to 'ensure access to affordable, reliable, sustainable and modern energy for all' by 2030. Action towards the target is particularly important for the 66 million forcibly displaced people in the world who have an acute energy access deficit.

The Moving Energy Initiative (MEI) is an international consortium seeking to change how the humanitarian system responds to the issue of energy. While initial literature reviews for the project were carried out in 2014, the consortium was formally inaugurated in 2015 as a partnership between Energy 4 Impact, Practical Action, the Office of the United Nations High Commissioner for Refugees (UNHCR), the Norwegian Refugee Council and Chatham House. Funding for this publication, and for the wider activities of the MEI, has come from the UK Department for International Development (DFID).

In 2015 the MEI report *Heat, Light and Power for Refugees: Saving Lives, Reducing Costs* shone a spotlight on the energy deficit suffered by displaced people, and on the gap in understanding of energy access in humanitarian settings. It was the first publication that attempted to quantify the amount of energy used by forcibly displaced people around the world, and to establish how much they paid for it.

This research paper examines the issue in more detail, using insights from refugees in camps in Burkina Faso and Kenya. It seeks to promote a better understanding of their energy needs, priorities and preferences, and explores how increased access to energy might help to achieve lasting impact in the two camps surveyed. The paper is based on primary research from the Goudoubou camp in Burkina Faso and the Kakuma I camp in Kenya, but the analysis and conclusions are pertinent in the wider context of camps for forcibly displaced people.

For more details on the MEI, see www.movingenergy.earth.

Executive Summary

The low level of energy access in refugee camps is sorely felt by displaced people. Expensive and dirty technologies contribute to poverty, and hamper relief and development efforts. Moreover, the negative impacts of inadequate access to energy cause greatest harm to the most vulnerable. Modern technologies and private-sector approaches offer the chance to improve lives and reduce costs, but the humanitarian sector is not yet taking advantage of the opportunities available. A transformation is required for the benefits of innovative energy technologies and policies to be widely and deeply felt.

This paper draws on primary research to present the energy access situation in the refugee camps of Goudoubo in Burkina Faso and Kakuma I in Kenya.¹ It focuses on cooking, lighting and power in the home, and on energy for enterprises and camp facilities such as clinics, schools, water pumps and street lights. For the first time a detailed insight into displaced people's energy priorities and preferences, and their willingness to pay for access to energy, is presented. The authors' approach draws on detailed quantitative sampling, as well as on in-depth qualitative analysis.

There is clear dissatisfaction on the part of refugees, camp administrators and humanitarian workers with the current level of energy provision in the camps, and a corresponding demand for change. This paper outlines several energy scenarios, produced with contributions from refugees, that would represent a dramatic improvement in the lives and life chances of displaced people. It provides a picture of the economics of each scenario, showing the capital and operating requirements and the projected savings relative to a 'business as usual' baseline. Drawing on example projects and research from the Moving Energy Initiative (MEI), the paper also explores how private-sector engagement offers the possibility of delivering innovative and cost-efficient solutions.

There is clear dissatisfaction on the part of refugees, camp administrators and humanitarian workers with the current level of energy provision in the camps, and a corresponding demand for change.

The need to reform how energy is delivered in camps for displaced people is recognized. The energy scenarios presented in this paper are intended to open a debate among donors and humanitarian agencies about what solutions could most usefully be promoted, and about who can realistically receive access and at what cost. The scenarios have been defined using camp residents' responses to surveys in which they were asked about their preferred technologies and willingness to pay for them. The scenarios are intended to allow comparison and contrast of different approaches, thus to inform policy and practice.

¹ The statistics and data in this executive summary are from primary research and analysis by the Moving Energy Initiative project, with detailed citations in the main body of the paper.

Energy poverty in the Goudoubo and Kakuma I refugee camps

Cooking pots, solar panels and battery-powered torches were among the few possessions brought by some refugees from their homes; many families also received energy products upon arrival at the camps or through subsequent handouts. Despite this, there is a low level of energy access in both camps, which contributes to poverty and hampers relief and development efforts. Ninety-nine per cent of households in Goudoubo and 86 per cent of those in Kakuma I rank as Tier 0 or Tier 1 (out of six tiers) for cooking and lighting access on the Sustainable Energy for All (SE4All) index. These are the two lowest tiers in the index, signifying a severe deficit and a failure to meet basic levels of energy access commensurate with a healthy and productive life.

Table 1: Average household energy expenditure (\$ per month)

	Goudoubo	Kakuma I
Lighting	0.71	3.72
Phone charging	0.06	0.35
Cooking	6.94	4.99
Monthly energy expenditure	7.71	9.06
% of median income	15	31

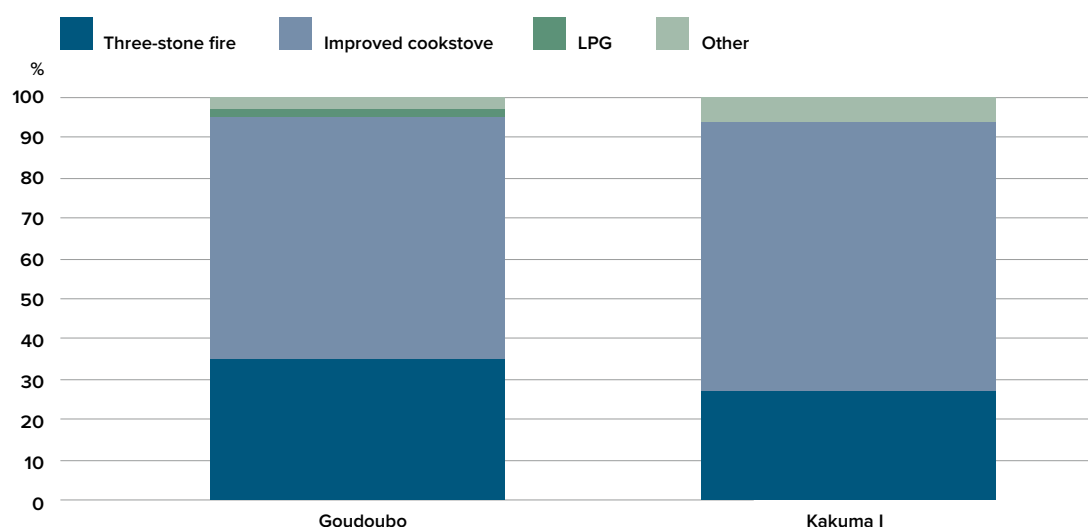
Note: The monetary expenditure reported in the survey does not include the cost of fuel rations or products received for free.

Table 1 shows that meeting basic cooking, lighting and phone-charging needs is costly for households in the camps, consuming a significant share of stretched monthly budgets. Handouts of cooking fuel are never sufficient, and families are forced to trade food rations for fuel or expose themselves to risk by collecting firewood. In the refugee economy, fuel sufficiency is necessary for food security.

The predominant cooking solution in the two camps consists of basic improved cookstoves burning wood and charcoal. The 'three-stone fire' method – the simplest cooking practice, in which a pot is balanced over a fire on three stones – also remains commonplace. Three out of five families in Kakuma I report health problems due to smoke from cookstoves. Women bear the burden of both cooking and wood collection. Gathering wood from surrounding areas that hold scant resources puts female refugees in Kakuma I at risk of sexual and gender-based violence;² in Goudoubo, the collection of firewood has been highlighted by refugees as a potential flashpoint with the host community, despite otherwise good relations between the two groups.

² UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*, <http://www.unhcr.org/ke/wp-content/uploads/sites/2/2016/05/Kenya-Comprehensive-Refugee-Programme-document-KCRP-20161.pdf>.

Figure 1: Primary cooking option



Household solar products are widespread. These have proved successful at providing bright lighting and power for charging mobile phones, at dramatically lower cost than other common solutions. For example, families in Goudoubo who use throw-away torches spend six times more on light than those with a quality solar product. In Kakuma I, 12 per cent of residents are connected to unregulated private mini-grids, with each household spending more than \$60 a year for a light and socket. Although this compares with around \$20 a year for a basic household solar product, the latter often cannot satisfy energy needs beyond simple lighting and phone charging.

Street lighting is also a high priority for residents, due to concerns about security and safety in camps. In Goudoubo, 86 per cent of survey respondents said that more household members would go out after dark if there were better public lighting.

In addition, implementing agencies rely on expensive diesel generators to power critical camp facilities. Many services have to manage without generators. Two diesel water pumps in Goudoubo cost \$31,000 a year to run, and a generator for a health clinic in Kakuma I costs \$168,000 a year.

Ten opportunities for change

1. **A significant proportion of refugees would pay for cleaner and more efficient energy technologies.** In Goudoubo, two-thirds of residents surveyed expressed a willingness to pay for cooking solutions, indicating a potential customer base of 2,000 families and a market worth up to \$270,000 per year. In Kakuma I, more than one-third expressed a willingness to pay for quality household solar products, indicating a potential customer base of 5,000 families and a market worth some \$300,000. While this study did not assess refugees' ability to pay, it is clear that many lack the financial resources required, and that the development of markets for such products is therefore contingent on sustained financial support from donor agencies.³

³ Other important income streams include employment, business and remittances. Displaced people's income, and their ability to pay for access to energy services, is a topic that merits further research.

2. **There is a need for a diversity of energy technologies** that give varying levels and qualities of service; a 'one size fits all' approach is inappropriate if universal access to sustainable energy is to be achieved. Stove promoters need to recognize and respond to the diversity of refugees' requirements. Likewise, a combination of a centralized electricity supply system for camp facilities and refugee enterprises and a range of solar products for households is required.
3. **Clean cookstoves and fuels are in high demand, but require much greater investment if they are to be introduced at scale.** The majority of families would like to cook on stoves that use less fuel and produce less smoke. Clean cooking appears attractive if the full economic benefits (financial, health, environmental) are calculated. However, achieving this would require two to four times the current level of funding.
4. **Solid biomass and improved cookstoves will continue to be important cooking solutions in Kakuma I and Goudoubo, as well as in other refugee camps.** A shift to more efficient cooking can be achieved at little or no extra cost for the significant proportion of people who still cook on three-stone fires. Universal adoption of improved cookstoves would reduce fuel consumption and expenditure. The prodigious wastage of three-stone fires is evident when the full economic cost of their use is considered.
5. **Quality-verified household solar products meet the basic needs of families and are low-cost.** Users of these products spend dramatically less on light and power than do people using inferior technologies. Quality-verified household solar products therefore represent good value for money for refugees and donors. Strong brand recognition and a high willingness to pay indicate a large market and a significant opportunity for the private sector.
6. **Centralized electricity supply solutions – mini-grids or grid connections – are more economic than multiple standalone diesel generators.** A grid connection or mini-grid supply is a good option for camp facilities and enterprises where demand for power is high and costly diesel generators are the alternative. The current piecemeal and ad hoc approach, with each facility managing its own power supply, is inherently wasteful. Greater coordination among humanitarian clusters is required so that centralized solutions can be assessed, designed, financed and implemented. Extending such services to higher-income households may also be viable, though providing universal coverage to refugee households via centralized solutions is likely to be prohibitively expensive.
Solar-diesel hybrid mini-grids are more economical than purely diesel systems, but they carry a high upfront cost and require robust risk management.

In situations where the refugee camp and host community are close to each other – such as at Kakuma I – there is opportunity for a cost-efficient mini-grid that can supply both constituencies on equitable terms. The Office of the United Nations High Commissioner for Refugees (UNHCR) could provide the impetus for the investment required through power-purchase agreements or guarantees.

7. **Purely solar-powered water-pump schemes are viable in most camps for displaced people.** These schemes offer a quick return on investment (typically one to three years) and substantial cost-saving opportunities. A robust context analysis that assesses security and identifies a local operation and maintenance model is necessary to ensure the success of such installations; capacity-building of water, sanitation and hygiene (WASH) teams is also a prerequisite.

8. **Collecting data** on energy expenditure and use, as well as quantification of the wide-ranging impacts of improved technologies, **is necessary to build a compelling case for investment** in electricity infrastructure.
9. **Engaging refugees on their needs, preferences and willingness to pay can improve the sustainability and impact of energy interventions.** In both of the camps surveyed, there have been problems with projects that involved handing out energy products to refugees, only for the products to subsequently break down or be sold at the market. This defeats the purpose of distributing products for free, and underlines the importance of engagement with refugees to understand their needs and promote a sense of 'ownership' in respect of energy products and facilities.
10. **Private-sector and market development approaches offer long-term, cost-effective solutions for refugees and can also benefit host communities.** As the number of displaced people in the world increases, and as aid budgets come under further pressure, the imperative to identify cost-effective and sustainable solutions is more pressing than ever. Humanitarian actors have recognized the need to move from offering free handouts to engaging with local markets for provision of products and services for post-emergency response. However, their engagement with the private sector requires a transformation in mindset and approach if greater impact and sustainability are to be achieved in energy interventions.

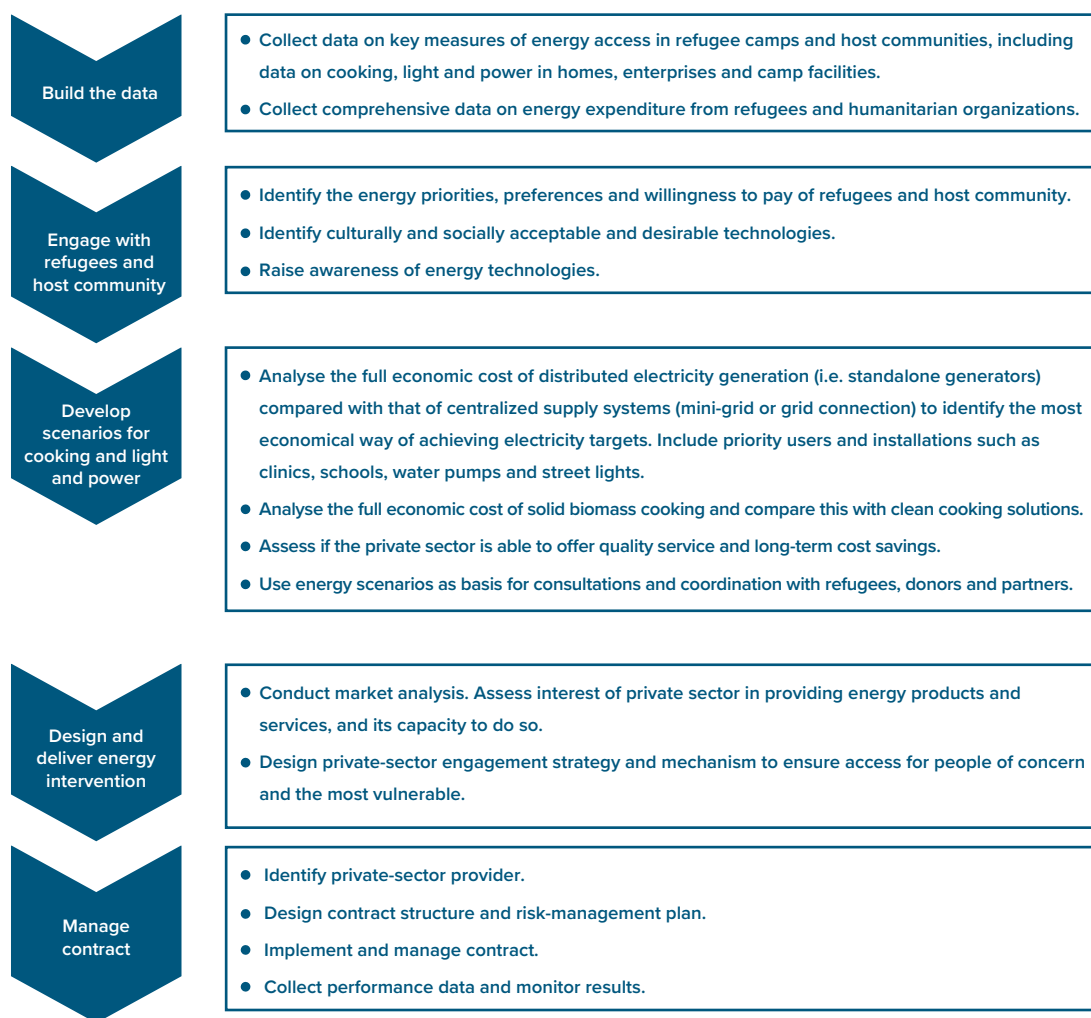
As the number of displaced people in the world increases, and as aid budgets come under further pressure, the imperative to identify cost-effective and sustainable solutions is more pressing than ever.

Companies agree that they could play a critical role in this space, as they have the expertise and incentives to improve refugees' access to energy products and services. Companies also note that significant cost and operational efficiencies could be achieved by shifting to alternative technologies and by optimizing energy access supply chains. Private-sector capital financing is also a possibility if revenues can be guaranteed through structures such as power-purchase agreements, and if robust risk management is applied. This research paper presents the results from projects, conducted by the MEI in the two camps, that explore private-sector engagement for increasing energy access.

Agenda for change

More cost-effective and impactful ways of delivering energy access are possible, and can be achieved by following the agenda for change set out in Figure 2.

Figure 2: An agenda for improving refugees' energy access




Prices, Products and Priorities

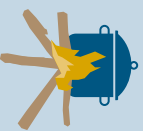
Meeting Refugees' Energy Needs in Burkina Faso and Kenya


An estimated 80 per cent of the 8.7 million refugees and internally displaced people who currently live in camps have minimal access to energy, which contributes to poverty and hampers relief and development efforts. Modern technologies and private-sector approaches offer the chance to improve lives and reduce costs, but the humanitarian sector is not yet taking advantage of the opportunities. MEI research draws on primary research to present the energy access situation in the refugee camps of Goudoubo in Burkina Faso and Kakuma I in Kenya.

Context

 99% of households in Goudoubo and 86% in Kakuma I rank Tier 0 or Tier 1 (out of six on the SE4All index) for cooking and lighting access.


Cooking on three-stone fire
1/4 families in Kakuma I,
1/3 families in Goudoubo.



 In Kakuma I, the average household expenditure on energy is equivalent to 31% of the median income.

 6x

Families in Goudoubo using battery-powered torches spend 6x more than families using a solar light.

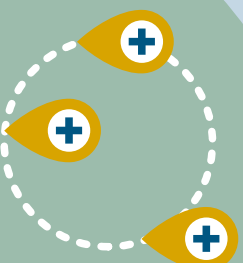
 In Goudoubo 86% of people say more members of their household would go out after dark if there was better public lighting.

“ If I had power I would keep my restaurant open at night & earn more.”



Key Success Factors

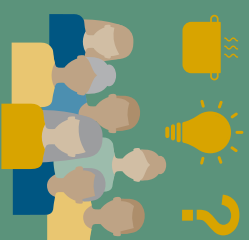
Greater coordination among humanitarian agencies is required to design & manage more efficient energy supplies



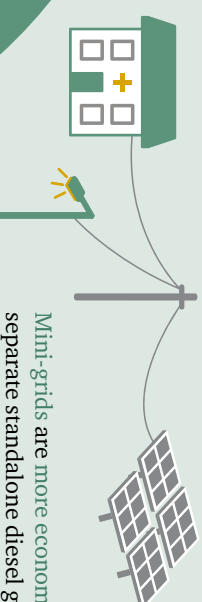
Private-sector approaches offer long-term, cost-effective solutions & benefits to the host community



Engaging refugees on energy needs & priorities can enhance the sustainability and impact of projects



Solutions



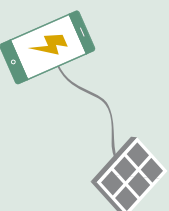
Mini-grids are more economical than separate standalone diesel generators.

Solar-hybrid is cheaper than diesel.



To pump water, solar power is more economical than a diesel pump in most cases.

Household solar products meet basic needs & are good value for money.



Solid biomass improved cookstoves are an important intermediate technology.



Clean cookstoves & fuels are in high demand but require much greater investment to scale up.



moving energy initiative

1. Introduction

An estimated 80 per cent of the 8.7 million displaced people who currently live in refugee camps have minimal access to energy, with a high dependence on traditional biomass (such as firewood and charcoal) for cooking and no access to electricity.⁴ The UN Sustainable Development Goal 7 emphasizes the centrality of energy in improving human well-being; energy is the thread that connects economic growth, social equity and environmental sustainability.

And yet there is limited knowledge of the realities of the energy access situation for displaced people in camps. For the most part, how people cook, light and power their lives, and the implications this has for their prosperity and well-being, is poorly understood. Humanitarian organizations do not routinely collect energy access data, and no standardized methods exist for measurement and reporting. The lack of quality data prevents a better understanding of the problems camp residents face and hinders development of solutions that could improve their lives. Energy interventions have largely focused on handouts of energy products and firewood that fail to meet refugees' full needs and preferences. In the absence of an institutional 'home' for energy in the humanitarian framework, energy supply is typically provided in an ad hoc and piecemeal manner, leading to displaced people's needs being met inadequately and inefficiently.

In the absence of an institutional 'home' for energy in the humanitarian framework, energy supply is typically provided in an ad hoc and piecemeal manner, leading to displaced people's needs being met inadequately and inefficiently.

The aim of this research paper is to enhance humanitarian agencies' understanding of the state of energy access for displaced people living in camps, and to provide ideas as to what can be done to improve the situation. The paper presents a detailed picture of the energy situation in Goudoubo camp in Burkina Faso and Kakuma I camp (part of a larger cluster of five settlements) in Kenya. It looks at energy supply and use in households, enterprises and community institutions, and details how displaced people cook, light their homes and power their devices. It asks critical questions such as: What energy technologies are being used? How much do people spend on energy? Where do people obtain energy products and supplies from? What are the priority energy needs for displaced people? What energy technologies would they like, and how much are they willing to pay for them?

The paper draws on surveys and interviews with key informants conducted by the Moving Energy Initiative (MEI) consortium (see Preface for details) in late 2016 and early 2017. Consultations sought refugees' perspectives on their energy priorities, preferences and willingness to pay for different energy products and services. Anthropological research by the University of Edinburgh and Practical Action (a member of the MEI) added further social and cultural insights into the everyday energy experiences in the two camps. These insights aim

⁴ Lahn, G. and Grafham, O. (2015), *Heat, Light and Power for Refugees: Savings Lives, Reducing Costs*, Chatham House Report for the Moving Energy Initiative, London: Royal Institute of International Affairs, <https://www.chathamhouse.org/publication/heat-light-and-power-refugees-saving-lives-reducing-costs>.

to demonstrate that engaging with displaced people is an important step in delivering energy access projects with greater impact and at less cost. The research paper illustrates the value of capturing rich energy data, and offers a framework for organizations wishing to collect and report data themselves.

The refugee perspectives are combined with economic analysis to establish energy access scenarios that, if implemented, would represent a significant improvement in access to energy. The scenarios reflect refugees' preferences, and are intended to inform policy and practice by showing the demand that exists for different solutions, and the associated costs and savings implied for camp administrators. The scenarios open a discussion of the potential interventions and level of finance required to achieve the results. MEI projects are presented as examples of innovative ways to engage the private sector to increase access while reducing costs.

The Sustainable Energy for All (SE4All) Global Tracking Framework (GTF)⁵ is used as a basis for reporting access to cooking and electricity. It ranks access from Tier 0 (harmful, inadequate and inefficient forms of energy) to Tier 5 (modern, clean and versatile forms of energy). Each tier is defined by the capacity, duration, reliability, quality, affordability, legality, and health and safety of the energy supply.

While recognizing that many displaced people live in urban areas, this paper focuses on the energy situation in refugee camps. It mainly refers to 'refugees', but is pertinent in the wider context of forcibly displaced people. For simplicity, the terms 'refugees' and 'displaced people' are used interchangeably in this paper.

Other relevant MEI publications include the forthcoming *Costs of Fuelling Humanitarian Agencies*,⁶ which will present the energy use and costs of humanitarian organizations in camps; and *Private-Sector Engagement: The Key to Efficient, Effective Energy Access for Refugees*,⁷ published in 2016, which analyses challenges, approaches and delivery models.

⁵ A definition of the multi-tier framework can be found at www.esmap.org/node/55526.

⁶ Grafham, O. and Lahn, G. (forthcoming 2018), *Costs of Fuelling Humanitarian Agencies*, MEI. This publication will also report fuel consumption arising from vehicle usage.

⁷ Van Landeghem, L. (2016), *Private-Sector Engagement: The Key to Efficient, Effective Energy Access for Refugees*, Toolkit for the Moving Energy Initiative, <https://www.chathamhouse.org/publication/toolkits-moving-energy-initiative>.

2. The Context in the Camps

Goudoubo

In 2012, Mali's north fell to Al-Qaeda-linked Touareg rebels demanding an independent state. Tens of thousands of people escaped the fighting, with many fleeing across the desert border to neighbouring Burkina Faso. Many refugees were Touareg herdsman who fled with livestock; others from Timbuktu and other cities left with few possessions.

Security has improved in northern Mali after a peace agreement, though armed groups remain and clashes and incidents are recurrent. Refugees have been slow to return home. Northern Mali's social fabric has been deeply damaged; many refugees say they have no choice but to remain in Burkina Faso for their own safety and security. 'Our initial vision was based on repatriation. We now need to help them to become self-sufficient,'⁸ explains the resident representative of the Office of the United Nations High Commissioner for Refugees (UNHCR).

Goudoubo camp was established in 2012. It is one of three official sites, alongside Mentao and Saag-Nioniogo, that together house more than 34,000 refugees.⁹ Goudoubo has 3,098 households and more than 10,000 people, 54 per cent of whom are below the age of 18, with a roughly even number of males and females.¹⁰ The vast majority of residents are Touareg, with Fulani, Songhai and Arab minority groups also present. The camp has capacity for 21,000 refugees.

Families receive food rations and a UNHCR cash transfer of \$35 per month; other money sources bring the mean income to \$53 per month.¹¹ Rearing livestock, basic commerce and employment with non-governmental organizations (NGOs) are the other main sources of income. Around 15 per cent of shelters are UNHCR tents; the rest are traditional huts made of branches and sheets or hides.

Refugees have access to basic services including healthcare, water and sanitation, shelter, education and non-food items. UNHCR is the camp coordinator, and 14 NGOs and agencies play various roles in delivering services. Refugee committees representing elders, women and youth have been established to support coordination and consultations.

As is the norm with humanitarian response, a lack of funds is hampering service delivery in the camp. As of June 2015, UNHCR had received just 17 per cent of the \$21 million requested to support activities in the country.¹² The uncertain future of the refugees and the camp, combined with the budget constraints, makes it difficult to plan improvements.

⁸ Thomas, K. (2016), 'In Limbo: Malian Refugees in Burkina Faso', News Deeply, 20 April 2016, www.newsdeeply.com/refugees/community/2016/04/20/in-limbo-malian-refugees-in-burkina-faso.

⁹ UNHCR (2013), 'Goudoubo camp profile', <https://data2.unhcr.org/en/documents/details/33725>.

¹⁰ This figure from September 2013 is used consistently in the analysis in this research paper, although the camp's population is fluid.

¹¹ Practical Action 2016 survey data. Handouts have reportedly decreased since then. Other income sources include employment, livelihoods and other cash transfers. At \$35 a month per family, this means that UNHCR cash handouts cost \$1.3 million per year.

¹² UNHCR (2015), 'Burkina Faso: UNHCR Operational Update', June 2015, <https://reliefweb.int/report/burkina-faso/burkina-faso-unhcr-operational-update-june-2015>.

Goudoubo is in the Sahel, a semi-arid belt between the Sahara to the north and the savannahs to the south. A short and unpredictable rainy season in the region creates chronic food insecurity. The camp is located 17 kilometres from Dori, the capital of Seno province, in the northeast of the country. Dori is 235 kilometres from the capital, Ouagadougou, and 200 kilometres from the border with Mali. Dori has a population of 18,000, with the main ethnic group consisting of Fulani, alongside Touaregs, Songhai and Hausa. Islam is the predominant religion. Dori is a commercial hub with a bustling livestock fair. Mining is also important to the local economy.

Relations between the host community and refugees are seemingly good. Some people from the host community live within the camp perimeter, and local children attend the camp schools. A shared language among some groups, along with food and fuel exchanges and other commerce, facilitates interactions. Refugees in Burkina Faso are legally entitled to work (with some working for agencies in the camp), but few have found formal employment.

A shared language among some groups, along with food and fuel exchanges and other commerce, facilitates interactions.

Burkina Faso is ranked 185th in the Human Development Index¹³ of the United Nations Development Programme (UNDP), and has a gross national income per capita of \$620.¹⁴ Food insecurity and severe malnutrition are at crisis levels throughout the country. A failed coup in 2015 damaged the economy and has led to political instability.

Kakuma I

Kakuma camp was created in 1992 by UNHCR and the Kenyan government to accommodate 12,000 refugees fleeing war in Sudan. It now hosts 187,000 refugees from across the region, including from South Sudan, Ethiopia, Somalia, the Democratic Republic of the Congo (DRC) and Burundi.¹⁵

Kakuma is in the remote northwest of Kenya, more than 700 kilometres from Nairobi and 130 kilometres from the border with South Sudan. It is located in Turkana, the second-poorest region in the country. It has a harsh climate, being a semi-arid region with temperatures reaching above 40°C. There is little suitable agricultural land, and wooded areas and biomass are scarce.

Located adjacent to Kakuma town, which has 60,000 inhabitants, the camp is now an established settlement and an important feature in the socio-economic landscape of the area. Aid agencies help sustain the local economy with food rations and expenditure on camp operations and staff. The overall Kakuma camp complex consists of five zones (Kakuma I–IV, plus the new Kalobeyei site), reflecting the influx of refugees from different crises. For the purposes of this paper, the term 'Kakuma' refers to the entire complex unless Kakuma I is explicitly specified. The zones are roughly divided along national and ethnic lines. Those under the age of 18 make up 66 per cent of the population. Women account for 47.4 per cent of the population and men for 52.6 per cent.¹⁶

¹³ UNDP (2016), 'Table 1: Human Development Index and its components', UNDP Human Development Reports, <http://hdr.undp.org/en/composite/HDI>.

¹⁴ World Bank data for 2016, <https://data.worldbank.org/country/burkina-faso?view=chart>.

¹⁵ UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

¹⁶ UNHCR (2017), 'South Sudan Situation Report', UNHCR Information Sharing Portal, www.data.unhcr.org. Data based on 76,923 South Sudanese refugees resident in Kakuma.

The Turkana people are traditionally semi-nomadic pastoralists with persistent high rates of poverty. There is fierce competition for water and grazing for livestock. To secure grazing for the host community and avoid conflict, refugees are prohibited from owning livestock.

With no right to work or live outside the camp, the majority of refugees remain entirely dependent on aid agencies.¹⁷ Only 8 per cent of the population of Kakuma engage in livelihood activities and/or have means of survival other than the assistance provided.¹⁸ That is not to say that entrepreneurial activity is absent: indeed, at least five US-dollar millionaires are said to live in the Kakuma camp, having become rich trading hardware, clothing and food.¹⁹ Most relatively well-off refugees reside in Kakuma I²⁰ (43 per cent) and Kakuma II (36 per cent), with only a few (7 per cent) in the more recent Kakuma IV settlement. Ninety per cent of the refugees considered 'wealthy' by camp standards arrived before 2014. Among relatively affluent Kakuma camp residents, the biggest group (59 per cent) originates from Somalia, while refugees from Ethiopia and the DRC represent 11 per cent each.²¹ Kalobeyei is populated almost exclusively by South Sudanese, who are the poorest group. The level of infrastructure varies hugely between the camp's different zones.

Real and perceived differences in investment and access to services are a source of ongoing tension between refugees and the host community. The economic potential of the camp has not been fully utilized, yet the host community is one of the most marginalized in Kenya. Its members feel that they have not benefited much from the presence of refugees.²²

Kakuma I consists of 14,000 homesteads, or 26 per cent of the overall complex's total.²³ Houses are arranged quite densely, and are constructed of mud bricks and roofed with corrugated iron sheets. Land around the camp is owned by host communities, with elders and local government presiding over land-use agreements. UNHCR Kenya coordinates the aid work of the numerous agencies and NGOs present. Kakuma I camp has large health clinics, numerous schools, water supply networks, administrative centres, and food and fuel distribution centres.

Kakuma town is not served by the national electricity grid, which only reaches as far as Lodwar, 200 kilometres away, though the Rural Electrification Agency is building a diesel mini-grid to serve it. This is being eagerly awaited by town residents, humanitarian agencies and refugees alike, though indications suggest the supply will be limited to 5,000 customers.

Kenya has a mature and innovative off-grid electricity market, with leading companies such as M-Kopa, d.light and BBOX proving successful. However, these providers have limited reach in remote corners such as Turkana. Kenya hosts 596,000 refugees – the majority in a second major camp, Dadaab, on the Swahili Coast bordering Somalia. The government has committed to closing Dadaab camp and has started repatriation or relocation of its residents to Kakuma.

¹⁷ Refugees are not allowed to work for a salary but can receive a stipend up to a maximum of KES 6,000 (\$60) per month.

¹⁸ Guyatt, H., Della Rosa, F. and Spencer, J. (2016), *Refugees Vulnerability Study, Kakuma, Kenya*, UNHCR, World Food Programme and Kimerica, https://www.kimerica.com/files/uploads/files/pdf/Refugee_HH_Vulnerability_Study_Kakuma_Refugee_Camp_Final_Report_2016_05_06.pdf.

¹⁹ Hargreaves, K. (2017), 'Smart solar solutions: improving energy access and empowering refugee communities in Kenya', Crown Agents blog, 20 June 2017, <https://medium.com/@crownagents/kate-solar-blog-d77686454f26>.

²⁰ The quantitative data in this paper therefore represent the relatively wealthier residents of Kakuma I and not the entire camp average.

²¹ Guyatt, Della Rosa and Spencer (2016), *Refugees Vulnerability Study, Kakuma, Kenya*.

²² UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

²³ UNHCR (2016), 'Kakuma Camp Population Statistics by Country of Origin, Sex and Age Group', UNHCR Information Sharing Portal, September 2016.

3. The Energy Access Situation: Cooking, Light and Power in the Camps

Cooking pots, solar panels and battery-powered torches were among the few possessions that some refugees brought from their homes to the Goudoubo and Kakuma I camps. In addition, many families received energy products upon arrival or through subsequent handouts. Despite this, there is a low level of energy access in both camps. This contributes to poverty and hampers relief and development efforts. Ninety-nine per cent of households in Goudoubo and 86 per cent of those in Kakuma I rank as Tier 0 or Tier 1 on the SE4All index in terms of cooking and lighting access (see Chapter 1 and Annex 1, Table 18 for details). This signifies a severe deficit and a failure to meet standards commensurate with a healthy and productive life.

Residents use rudimentary cookstoves or the 'three-stone fire' method (simply balancing a pot over a fire on three stones) – in both cases, obtaining fuel is a burden that strains family budgets and raises vulnerability (as women and girls are at risk of attack when collecting firewood). Both camps are located in semi-arid regions with a natural scarcity of wooded areas and biomass resources, making fuels expensive.

Entry-level solar products are common, but these meet only the most basic lighting and charging needs. Privately run mini-grids, non-quality-verified solar home systems and truck batteries provide more service for a few households, but at great cost. Kakuma I's residents have a greater choice of energy products and services than do those of Goudoubo, reflecting the more established nature of the camp complex and Kenya's more dynamic off-grid market. Still, entrepreneurial activities are constrained without a reliable and affordable power supply.

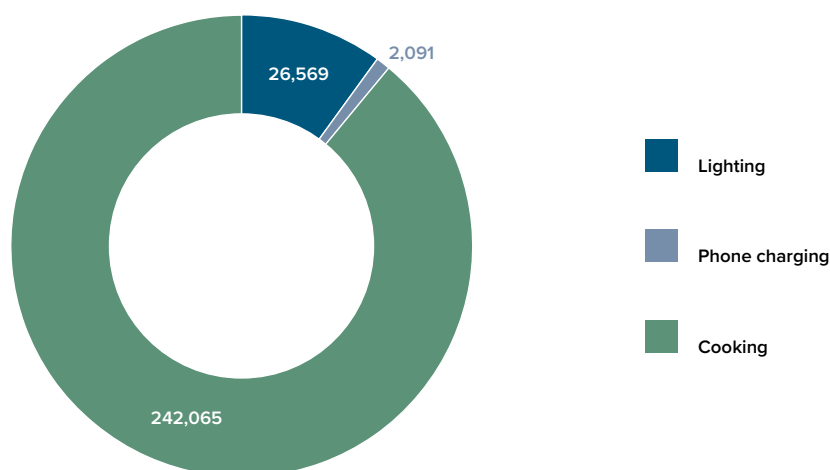
Neither camp has a grid connection or a centrally organized mini-grid system; instead, priority facilities such as health clinics receive power from an array of standalone diesel generators. In each camp there is an active Energy and Environment Working Group, run by UNHCR. However, as with other sectors, budgets for energy interventions are underfunded.

Box 1: Research samples and definitions

The MEI collected detailed data through surveys and interviews with key informants in the two camps in late 2016 and early 2017. The sample size and respondent recruitment process aimed to obtain a representative sample in each camp. In Goudoubo the sample consisted of 123 household respondents, 38 enterprises and 10 community facilities; in Kakuma I it consisted of 231 household respondents, 79 enterprises and 15 community facilities, selected at random from each block in the camp. For Kakuma, the quantitative survey data were collected exclusively from Kakuma I, while the qualitative research covered the overall camp complex.

Goudoubo camp

Figure 3: Total annual household energy expenditure (\$) in Goudoubo camp



Note: The figures represent monetary expenditure by households, and do not include the cost of fuel donated, traded or collected, or of products received. The figures do not include implementing partners' expenditure on diesel.

The residents of Goudoubo spend a total of \$270,000 a year on poor-quality and harmful energy supplies (see Figure 3). Households spend an average of \$87 per year on (inadequate) cooking, lighting and power.

Implementing partners reported spending \$85,000 per year²⁴ on diesel generators that power camp operations, a clinic and two water pumps.²⁵ Four hundred tonnes per year of firewood²⁶ were delivered and distributed until provision ended in 2017. The main energy burden on family budgets remains cooking, consuming 13 per cent of monthly income (see Table 2).

A high proportion of residents have solar lanterns for lighting and phone charging, which reduces their energy expenditure. Households without solar lanterns spend an average of \$2.51 per month on lighting and \$0.56 per month on phone charging, six times more than the amounts spent by neighbours who have such products.

Table 2 shows that average household energy expenditure accounts for 15 per cent of the median income. This is a relatively small proportion compared to that in other refugee camps, where energy spending typically consumes up to 50 per cent of a family's income.²⁷ It seems that solar products with light and phone charger, in particular, are effective in further reducing expenditure by refugees.

²⁴ Graffham and Lahn (forthcoming 2018), *Costs of Fuelling Humanitarian Agencies*. This publication will also report fuel consumption arising from vehicle usage.

²⁵ Key informant interviews conducted by Practical Action.

²⁶ UNHCR presentation at the Clean Cooking Forum in Ghana, 2015.

²⁷ As is the case in Nyarugusu refugee camp in Tanzania. Rivoal, M. and Haselip, J. (2017), 'The true cost of using traditional fuels in a humanitarian setting. Case study of the Nyarugusu refugee camp, Kigoma region, Tanzania'. UNEP DTU Partnership.

Table 2: Monthly average household energy expenditure in Goudoubo camp (\$)

	Expenditure (\$/month)	% of median income
Lighting	0.71	1
Phone charging	0.06	0
Cooking	6.94	13
Total energy expenditure	7.71	15

While the national electricity grid passes overhead, it does not yet serve the camp; diesel generators provide limited supply to a few facilities operated by humanitarian agencies.

Cooking

Sixty per cent of camp residents use a basic improved cookstove, albeit of minimal quality, and 35 per cent use a three-stone fire (see Table 3),²⁸ which means that 95 per cent have only Tier 0 or Tier 1 level cooking facilities. Firewood is the prevalent cooking fuel, though charcoal is also used. One-third of households use a secondary cookstove, and stacking of wood and charcoal and alternating fuels for cooking is a common practice. Since Goudoubo's historically nomadic refugees have traditionally cooked with a three-stone fire, this indicates the success of past stove projects in the camp in promoting alternative technologies.

Cooking is mainly done by women outside of the shelter. The food ration includes rice, beans and a corn-soy blend. The primary stove is lit for an average of five hours – which includes time for cooking and heating water – per day.

NGOs operating in the camp have organized training programmes on building and repairing improved cookstoves. Blacksmiths now produce a more efficient metallic model designed in Burkina Faso to be culturally appropriate and to use charcoal and wood. Women's groups have been trained in the use of wood-burning clay improved cookstoves that are low-cost but fragile.

The basic improved cookstoves cost \$1–5, though they have been distributed to refugees free of charge in the past. A liquefied petroleum gas (LPG) stove and cylinder cost about \$70, and can be purchased in nearby Dori, though weaknesses in the supply chain mean that cylinders are not always available.

The amount refugees spend on fuel does not necessarily correspond to the amount of fuel they consume, given the various channels that exist for obtaining fuel. Counter-intuitively, households using improved cookstoves spend slightly more on fuel than do three-stone fire users, even though improved cookstoves are more efficient. It is thought that people cooking on three-stone fires collect more wood instead of purchasing it, but more research is needed to support this hypothesis. It is striking that LPG users spend the least on fuel. However, as they also cook with a secondary fuel, one cannot read too much into this fact.

²⁸ It is important to note that these data are from 2016, i.e. before the start of a programme distributing LPG stoves and cylinders. At the time of writing, nearly 30 per cent of the camp population have been beneficiaries of the programme, with families of five members or more being prioritized.

Table 3: Primary stove usage and fuel expenditure in Goudoubo camp

Primary	% of respondents	Fuel spend (\$/month)
Three-stone fire	35	6.51
ICS: Basic (wood)	54	6.61
ICS: Basic (charcoal)	6	8.53
LPG	2	5.84
Other	3	

Notes: ICS = Improved cookstove. The fuel spend figure represents monetary expenditure by households, and does not include the cost of fuel donated, traded or collected, or of products received.

Two types of solar cooker have been introduced to the camp by UNHCR and partners.²⁹ In the country as a whole, 236 solar cookers have been distributed across the three camps (including Goudoubo),³⁰ at a cost of about \$50,000. The perceived advantages of fuel-free cookers in the sun-rich Sahel are clear; however, the actual solar cookers distributed did not meet users' requirements and are now rarely in use. Refugees identified various issues with them: cooking can only be done in the day, and the sun can be unreliable; the use of solar cookers requires a different style of cooking and can flavour the food; the stoves are large and cannot be stored in the camp's small huts; and users are poorly trained in the operation and maintenance of such products. Refugees have repurposed the technology to meet their own household priorities: the cooker's metal sheet is used as roofing, the pots for animal feed, and the handles to build wheelbarrows for fetching water.

Refugees obtain firewood from various sources. They buy it in the camp market, collect it from the area surrounding the camp, receive it as a fuel ration (though this practice ceased in 2017), and trade food rations for it. Both refugees and members of the host community are involved in this trade, with a 10-kilogramme firewood bundle earning a vendor around \$0.50. Annex 1 shows the prices of wood fuel and charcoal sold in the camp.

Women bear the burden of wood gathering, spending six to eight hours per week on this. No incidents of sexual or gender-based violence were reported in the survey, though it is important to note that it was not designed as such a study and hesitation to share experiences may be expected. Most firewood gathering reportedly takes place at the periphery of the camp. This reflects advocacy efforts on the part of refugee communities sensitive to the possible dangers of collecting wood from areas further away.

The refugee committees have made an effort to work with surrounding settlements to improve relations with respect to deforestation. Reforestation projects have been attempted, but livestock from the refugee camp and host community have eaten the saplings.

Until recently, the international NGO HELP was responsible for distributing fuel-wood rations to camp residents on a monthly basis. However, refugees and implementing agencies alike recognized that these handouts did not come close to meeting needs. Each refugee received

²⁹ UNHCR and Caritas introduced the Blazing Tube solar cooker, costing \$200 per unit, www.caritas.org/2014/04/bring-sunshine/.

³⁰ UNHCR presentation at the Clean Cooking Forum in Ghana, 2015.

10 kilogrammes of wood per month. In a sign of the wood scarcity in the region, the firewood thus distributed was collected some 100 kilometres from the camps and delivered on lorries. UNHCR and its partners were unable to provide information on the cost of supply and distribution.

One-fifth of refugees reported exchanging food items for fuel – an act that, although prohibited by donors, is widely accepted.³¹ As one woman from the host community explained, 'I came here to sell or exchange the firewood I brought ... one bundle costs CFA 250 [\$0.40] and I exchange it for one kilo of rice, or two bundles for a small bottle of oil.' Other coping strategies mentioned by refugees include skipping meals or reducing portion sizes.

One-fifth of refugees reported exchanging food items for fuel.

The regional director for the Ministry of Environment in Dori reported that growing populations and an influx of refugees have contributed to increased desertification. The natural wooded land between the Sahel and the Dori floodplain is at risk from wood harvesting and livestock grazing. The refugee committees and NGOs expressed concern that it is only a matter of time before resource scarcity damages the good relations between the camp and the host community.

Light and power

Three-quarters of Goudoubo households have a solar lantern with built-in phone charger. Although such products provide much-valued services, they still provide minimal access to energy (corresponding to only Tier 0 or Tier 1) and cannot satisfy needs beyond simple lighting and mobile-phone charging.³² Solar lights improve welfare for most households; however, unsurprisingly, they do not seem to be transformational in the sense of helping to lift people out of poverty. Evidence from other studies suggests that access to solar lights increases children's light use and slightly increases the time boys spend studying, but there are no gains in study time for girls or shifts to more productive activity for adults.³³

Children (including those in the host community) who are enrolled in the camp school and have received solar lamps regularly charge them in the school grounds. One teacher explained: 'In the morning, every pupil connects the panel and the lamp under the supervision of the teacher. Solar panels are outside the classroom under the sun, and the lamps stay inside. Every pupil has labelled their own lamp for easy recognition and to prevent stealing.'

The solar lanterns found in the camp are manufactured by d.light, Greenlight Planet and Lagazel – well-known companies with products that adhere to global quality standards.³⁴ UNHCR funded a disbursement of solar products with a single light and phone charging in 2014, and the IKEA Foundation funded a further handout in 2016.³⁵

³¹ Food is also exchanged for other goods and services. On distribution days in the camp, members of the host community transport foodstuffs (as well as firewood) and other goods on donkey carts to refugee households. Food can also be used to settle small loans with host community members.

³² Tier 1 access corresponds to a minimum of 3 watts' supply, four hours of light per day, or bright task lighting and phone charging. Some quality products do not achieve this level but still offer valuable benefits to consumers.

³³ Rom, A., Günther, I. and Harrison, K. (2017), *The Economic Impact of Solar Lighting: Results from a randomised field experiment in Kenya*, SolarAid, Acumen, ETH Zurich and Google, https://www.ethz.ch/content/dam/ethz/special-interest/gess/nadel-dam/documents/research/Solar%20Lighting/17.02.24_ETH%20report%20on%20economic%20impact%20of%20solar_summary_FINAL.pdf.

³⁴ The product standards relate to brightness of light, product durability, truth in advertising and warranty. More information is on the Lighting Africa website, www.lightingafrica.org/products.

³⁵ Distribution was through the Brighter Lives campaign, www.ikeafoundation.org/campaigns/brighter-lives-for-refugees/. Globally, the IKEA Foundation has distributed 56,000 solar lanterns and 720 solar street lights.

Figure 4: Primary light and power sources in Goudoubo camp

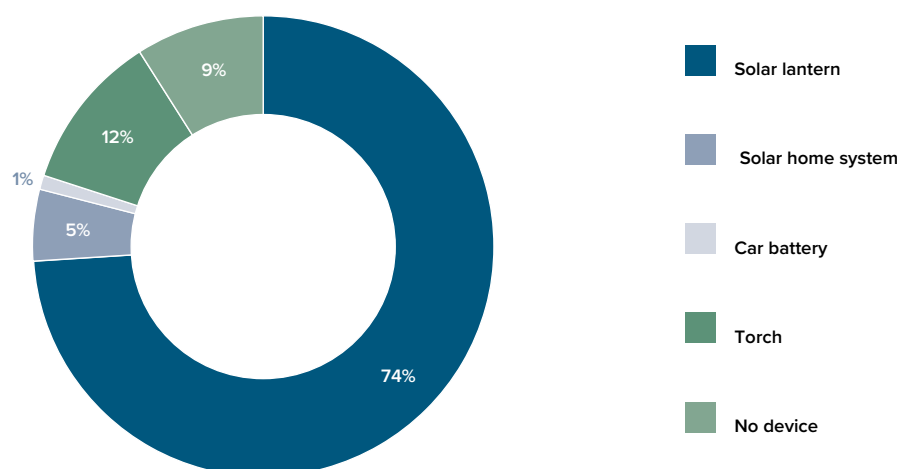


Table 4: Lighting and phone-charging savings realized by recipients of solar lanterns in Goudoubo camp

	Single household recipient		Aggregate of 2,350 recipients	
	\$/month	\$/year	\$/month	\$/year
Lighting savings	2.27	27.24	5,334	64,014
Phone-charging savings	0.56	6.72	1,316	15,792
Total savings	2.83	33.96	6,650	79,806

Distribution of quality solar products offers a rapid return on investment for humanitarian agencies. Table 4 shows the aggregated monthly savings realized by the 2,350 recipients of solar products coming to \$6,650 (where the amount saved is calculated in relation to the expenditure of families not using these products). The savings accumulated after nine months are equivalent to the cost of the project.³⁶ This represents good value considering the products' two-year warranty period and five-year design life.

While there are isolated instances of the lanterns being sold on to other users, the majority of households have kept them – a strong sign that these products are valued. Only one user reported their light had been stolen. Fewer than 5 per cent reported technical problems, usually after they had tried to modify the device to charge two phones at once. This is in contrast to a project in 2013 involving the distribution of 1,400 non-quality-verified products; the majority of these are now found to be not working.³⁷ UNHCR has since adopted the Lighting Global Quality Standards as a benchmark for all solar-lighting procurement.

³⁶ The estimated project cost is \$56,400 (\$20/unit x 2,350 products + 20 per cent administration cost). Savings on lighting and phone-charging costs are based on the expenditure of families in Goudoubo not using these products.

³⁷ UNHCR presentation at the Clean Cooking Forum in Ghana, 2015.

The majority of users recognize the brand of their product – a promising sign for potential distributors of branded goods. Studies show that consumers who have had a good experience with a branded product are much more likely to invest in another quality device.³⁸ However, new quality-verified solar products are not available on the local market. If families wish to buy a similar product in future, they will have to choose from inferior products that are likely to provide less light and have a shorter life.

Goudoubo camp sits on the path of a medium-voltage power line, but the camp is not yet connected to it and it is unlikely that refugee shelters will ever be provided with a grid connection (see 'Box 5: Connecting refugee camps to the national electricity grid – key issues' in Chapter 5). After solar lanterns, torches are the next most common lighting technology and are used by one in eight families. Torches and disposable batteries are bought on the local market at low cost, but unsurprisingly these have a short life. A select few refugee elders and block chiefs use solar home systems or large car or truck batteries. These can power lights and small televisions and charge phones. One refugee proudly displayed his television to a researcher: 'I bought the battery for CFA 30,000 [\$48]. The television can run for four hours when charged ... I go into Dori to charge it and put on films that I can bring back.'

Table 5: Number of hours with light at night, Goudoubo camp

Less than 1 hour	4%
1–2 hours	6%
2–3 hours	24%
3–4 hours	33%
>4 hours	33%

Table 5 shows that two-thirds of people in the camp enjoy four hours or less of light per night; many families are plunged into darkness long before going to sleep. A lack of social opportunities and entertainment is a common grievance, though 19 per cent of refugees own a radio, which many commented was important so that they could listen to the news. Constrained mobility and fear of encountering snakes and scorpions at night are also concerns. Only 24 per cent have a secondary device for lighting.

Phone charging

Nine out of 10 families own a mobile phone. Most charge their phones at home, with only 10 per cent of people paying to charge their phones. Those who pay to charge their devices do so on average three times per month at \$0.18 per charge. People who charge their phones at home use them more, typically charging them four times per month. Phone-charging businesses operate in the camp, though some people go to Dori to charge their phones or send their phones with others. A mobile-network operator has plans to offer mobile-money services in the camp.

³⁸ Global Off-Grid Lighting Association (2017), *Providing Energy Access through Off-Grid Solar: Guidance for Governments*, https://www.gogla.org/sites/default/files/resource_docs/energy_access_through_off-grid_solar_-_guidance_for_govts.pdf.

Enterprises

There is a low level of economic activity in the camp. Rearing livestock for milk and meat is common, but no refrigerators are available for cold storage. Leatherwork is a popular activity among artisans, who have access to solar lighting, gas blowtorches and bellows at the UNHCR-run artisan centre. Other enterprises that use energy include food stalls, restaurants and retail shops with phone-charging facilities. The camp also has a mechanic, a tailor and two blacksmiths, but these four workers only use rudimentary non-power tools. The majority of enterprises are owned and managed by men, though women run a small number of food stalls and restaurants. Enterprises are typically run out of the family shelter or from a temporary set-up in the central market.

Each enterprise typically has a solar lantern, or at best a larger battery system able to power more lights and a television. Two stall owners buy ice in Dori to sell chilled drinks and yoghurts. On distribution days, the number of entrepreneurs (both host and refugee) involved in this particular trade grows, with people using large plastic cool boxes to sell cold drinks and refreshments at distribution points.

In Goudoubo camp, there are at least seven mobile phone-charging and -repair businesses. All are male-owned, their operators comprising a mix of refugees and members of the host community. One owner proudly showed off his second-hand lead acid batteries and accompanying solar panels to highlight how he maintains a steady stream of customers. He said that he had bought his batteries and solar panels in Dori town, and that 'even the gendarmerie come here to charge their phones during the day'. Most mobile phone-charging businesses operate with second-hand lead acid batteries and at least one large solar panel (of 50–100 W).

The refugee executive committee in the camp emphasized that with access to electricity and lighting, shopkeepers could expand their hours of business and diversify the types of goods and services they are able to provide to the community.

Through HELP's improved cookstove programme, up to 20 male refugees have been trained as blacksmiths capable of building and repairing stoves, and several women have been trained to build clay stoves. The sale and repair of solar lanterns is also thought to offer a livelihood opportunity. However, one entrepreneur who was trained to repair mobile phones points out the lamentable lack of electricity: 'Yes, they [the customers] all pass by my business but I have not the required tools to repair, I haven't electricity, I have no soldering iron.' The refugee executive committee in the camp emphasized that with access to electricity and lighting, shopkeepers could expand their hours of business and diversify the types of goods and services they are able to provide to the community.

Community facilities and camp operations

The health centre has recently installed a 2-kW solar system for lighting, having previously operated a diesel generator. After initial problems with sub-standard batteries, the system is now reportedly working well. The facility is managed by the implementing partner, Centre de Support en Santé Internationale, and reportedly also provides health services to members of the host community working in a nearby informal mine. Two more diesel generators (10 kW and 12 kW) are used for pumping water. Maintenance of the three generators is handled by the NGO African Initiatives for Relief & Development, which in 2014 spent around \$31,000 on fuel and maintenance.³⁹

One of the schools has a number of small photovoltaic (PV) cells, donated by the Japan International Cooperation Agency, to light one room so that teachers can prepare lessons at night. The school canteen receives wood donations, but the supply is not always sufficient. One cook points out that 'when there is no firewood, all the canteen cooks go in the bush to collect it'. Some cooks take the leftover ash and charcoal home for their own cooking. On-site administrative offices are without power. As a result, implementing partners such as International Emergency and Development Aid (IEDA Relief), which is responsible for camp management, lack computers and even lights for their offices. Most activities have to be conducted using pen and paper or mobile phone.

Almost 100 solar street lights were installed in 2016, using funds from the IKEA Foundation. A survey prior to installation showed how the lack of light constrains mobility and social interactions: 86 per cent of respondents reported that more members of the household would go out after sunset if there were better public lighting.

The array of implementing partners and donors responsible for the clinic, schools, water pumps and administrative buildings is notable, and explains the piecemeal approach to electricity provision; no one agency is responsible for it.

Camp energy management

Decision-making on energy management and energy plans follows a hierarchy, with approvals needed first from refugee committees, then from implementing partners, UNHCR and ultimately the government. No refugee committee devoted to energy exists, though the executive, women's and youth committees have influence. HELP is the leading NGO partner on energy. It has developed a fuel-crisis strategy consisting of three components: promotion of alternative fuels for households, schools and the clinic; promotion of fuel-efficient improved cookstoves; and reforestation of the local area.

The UNHCR energy and environment officer has a mandate to develop and oversee energy activities in the camp. This mandate includes the following responsibilities:

- Developing the standards and norms for energy access for refugee households;
- Serving as technical adviser to the implementation partner (HELP) charged with energy and the environment;
- Developing the sustainable-energy access strategy for the camp;

³⁹ In a more recent study, implementing partners reported spending \$85,000 per year. Grafham and Lahn (2018, forthcoming), *Costs of Fuelling Humanitarian Agencies*.

- Monitoring and coordinating activities on the ground;
- Reporting to UNHCR and donors on camp issues related to energy and the environment; and
- Advocating that local and international institutions integrate energy and environmental issues into their activities around the camp.

Ultimately, the Ministry of Energy authorizes activities but in practice it is only concerned with larger infrastructure.

Host community

Burkina Faso has one of the lowest energy access rates in the world: 19 per cent of the population has access to electricity, a figure that falls to 3 per cent in rural areas.⁴⁰ Only 7 per cent of the population has access to clean cooking technologies. The national electricity grid serves Dori, though many of the town's inhabitants are not connected. Most cooking is done with biomass on basic cookstoves or three-stone fires. In this respect, the energy needs of refugees resemble those of the host community. Burkina Faso has a small market for decentralized energy products, with companies supplying solar products, improved cookstoves and fuels, though their reach extends to Dori in only a few cases.

Kakuma I camp

The residents of Kakuma I spend over \$1.5 million a year on poor-quality and harmful energy supplies (Figure 5). Each family spends more than \$100 per year on inadequate cooking, lighting and power. Cooking is the biggest household expense, though lighting is also a significant cost.

Kakuma I has an established market for cookstoves and light- and power-supply technologies, but 86 per cent of households are still rated at Tier 0 or Tier 1 access levels.

UNHCR distributes 10 kilogrammes of free firewood per person every two months. This equates to 935 tonnes per month for the entire camp of Kakuma, and costs more than \$1 million per year to deliver and distribute.⁴¹

Implementing partners in the camp also spend more than \$1 million per year to power compounds, health facilities, schools and other buildings.⁴² Each facility has a standalone generator. The result is an array of small power sources spread throughout the camp. The design, operation and maintenance of generators is rarely optimal, and these processes are therefore inefficient and costly.⁴³ One estimate puts the cost of running a generator at a single clinic at \$14,000 per month,⁴⁴ or \$168,000 per year.

⁴⁰ SE4All Global Tracking Framework, 2017.

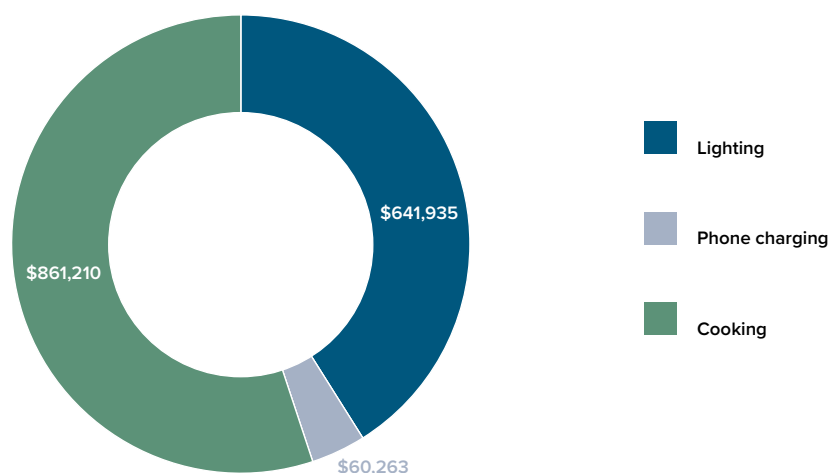
⁴¹ Cost data reported by UNHCR Energy Advisor.

⁴² Grafham and Lahn (forthcoming 2018), *Costs of Fuelling Humanitarian Agencies*. Figure relates to Kakuma camp as a whole. This publication will also include fuel consumption from vehicle usage.

⁴³ Lahn and Grafham (2015), *Heat, Light and Power for Refugees*.

⁴⁴ Hargreaves (2017), 'Smart solar solutions: improving energy access and empowering refugee communities in Kenya'. Other data from two primary health care clinics operated by the International Rescue Committee put diesel consumption at approximately 54,000 litres per year, with an annual cost of around \$58,000. Energy 4 Impact (2017), 'Moving Energy starts clean energy projects to boost health and enterprise in refugee camps', 4 July 2017, www.energy4impact.org/news/moving-energy-starts-clean-energy-projects-boost-health-and-enterprise-refugee-camps.

Figure 5: Total annual household energy expenditure (\$) in Kakuma I camp



Note: The figures represent monetary expenditure by households; they do not include the cost of fuel donated, traded or collected, or products received. They do not include expenditure by implementing partners on diesel.

Table 6: Average monthly household energy expenditure (\$) in Kakuma I

	Expenditure (\$/month)	% of median income
Lighting	3.72	13
Phone charging	0.35	1
Cooking	4.99	17
Total energy expenditure	9.06	31

Note: Median income value of KES 3,000 (\$29) taken from Guyatt, Della Rosa and Spencer (2016), *Refugees Vulnerability Study, Kakuma, Kenya*.

The energy and environment sector resource allocation for UNHCR in Kakuma was \$2.2 million in 2016, 7 per cent of the total budget available for the camp,⁴⁵ and was used to fund activities including firewood distribution, stove production, awareness raising and tree planting. Kakuma's Energy and Environment Working Group consists of representatives of the United Nations Food and Agriculture Organization (FAO), the German Corporation for International Cooperation (GIZ), Lotus Kenya Action for Development Organization (LOKADO), Sanivation, UNHCR Kenya, the World Food Programme (WFP) and World Vision International.

Cooking

Table 7 shows that one-quarter of families cook on traditional three-stone fires and that two-thirds use basic improved cookstoves. All households are rated Tier 2⁴⁶ or below, and are considered as using

⁴⁵ UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

⁴⁶ Thirty-one per cent are rated Tier 0, 42 per cent are rated Tier 1, and 27 per cent are rated Tier 2.

technologies that are inefficient, damaging to health and costly in terms of fuel consumption. Wood is the primary fuel for 77 per cent of families, though charcoal is also used extensively.

Table 7: Primary stove and fuel expenditure in Kakuma I

Primary stove	% of respondents	Fuel expenditure (\$/month)
Three-stone fire	27	4.77
ICS: Basic with wood	44	2.03
ICS: Basic with charcoal	23	9.78
Other	6	

Note: Fuel spending per month includes amount spent on primary and secondary fuels. It does not include the cost of fuel donated, traded or collected.

One Congolese woman explained that she prefers charcoal over firewood, but that she uses the latter because it is free. She said that ‘in my culture it is very shameful to have pots that are blackened by soot... When I cook with firewood, the pot gets completely black with soot at the bottom. Charcoal does not give me the same problem, so I prefer cooking with charcoal and it saves me a lot of time.’

The diversity of ethnicities in the camp is reflected in the assorted cooking practices and stove requirements. Typical foodstuffs include injera, sorghum, ugali (cornmeal), rice, porridge, beans, vegetables and tea. Meals require both high-heat fast cooking and low-heat slow cooking.

Women are always responsible for cooking. The primary stove is lit for an average of nine hours per day, compared to five for the secondary stove. More than half of families (56 per cent) cook inside, and 58 per cent report health problems as a result (mainly burns, or eye and respiratory difficulties from smoke). It is common to have the kitchen in a separate small building, which means that only women and children are exposed to smoke while cooking.

Refugees obtain firewood in various ways: receiving it as a fuel ration, collecting it from the area surrounding the camp, buying it on the local market, and trading food rations for it. Food and firewood rations are determined by family size, a seemingly equitable approach but one that disadvantages smaller families. As an Ethiopian woman testified: ‘We used to be a family of seven and life was good. We got seven portions of food and seven bundles of firewood. It was not plenty, but we could manage. We cooked twice a day. Now that we are just four, the firewood runs out. We can never make it two months. We need to spend money to buy extra firewood and charcoal. Everything has changed.’ A family is eligible for an additional food and fuel ration when a baby reaches two weeks of age, a moment that is thus a great cause for celebration.

Firewood collection around the camp is prohibited, though widely practiced as a strategy for families to reduce fuel expenditure. It is a time-consuming activity that increases residents’ vulnerability to assault. Women are particularly at risk, as they do most fuel collection and spend an average of four hours per week engaged in this activity. In one in three families surveyed, children were also reported to be involved in firewood collection, though only in one in 10 cases was this during

school hours. One-fifth of women reported having experienced a violent incident when gathering firewood in the past year, a figure thought to under-report the actual instances of assault given the sensitivity of sexual and gender-based violence and the ban on firewood gathering.

Refugees often exchange food rations for fuel with members of the host community.⁴⁷ A South Sudanese woman said: 'We always run out of firewood, how can we last two months with five bundles? This is impossible. The Turkana are walking around selling charcoal. I trade three bowls of sorghum for one basin of charcoal. It is a good deal.' In the refugee economy, fuel sufficiency is necessary for food security.

Most households practice fuel stacking: they alternate the use of different fuels according to factors such as type of meals, fuel prices and disposable cash. A small proportion of people use alternative fuels such as briquettes and LPG, though prohibitively high prices prevent their use as primary fuels. Families cooking with charcoal as their primary fuel spend nearly five times more on fuel than those using wood stoves, and twice as much as three-stone fire users. However, despite the expense (see Table 7), some refugees prefer to use charcoal for a variety of reasons. For example, people said that 'it cooks faster', 'you can leave the stove unattended and proceed to do something else', and 'firewood gives off too much smoke'.

LOKADO tenders the supply of the firewood ration to the host community. Most of the wood comes from the Mathenge tree, an invasive species gathered from the land of the Turkana surrounding Kakuma. It is chopped, portioned into bundles of 10 kilogrammes and trucked to the camp distribution centres for collection by refugees – a supply chain that supports a good few jobs for the host community.

There is also a vibrant charcoal market in Kakuma, with 23,000 bags entering the camp per month.⁴⁸ Each bag weighs 30–40 kilogrammes and costs \$7.5–8,⁴⁹ four times the price of wood by weight. This implies that the charcoal trade in Kakuma, which is run exclusively by the host community, has an annual value of \$2 million. The incomes and livelihoods created by the wood and charcoal trade are thought to contribute to the hostility of the host community towards refugees gathering fuel.

A wide variety of stoves are available in Kakuma; seven different types were listed by survey respondents. A locally made stove costs \$3–10, though such units are often available free of charge from UNHCR. The most popular is the Mandeleo Cooking Stove; 800 units are produced each month in the camp by LOKADO. All Mandeleo stoves are distributed free of charge to new arrivals – a controversial practice as the host community had been promised receipt of 10 per cent of the stoves produced.

Various efforts have been made to introduce alternative stoves and fuels, but with only mixed success. Solar Cookers International's first and largest refugee project ran from 1995 to 2004 and reportedly served over 15,000 families in Kakuma.⁵⁰ However, no respondents listed a solar cooker as their primary or secondary stove. A pilot project by Sanivation produces briquettes with a mix of charcoal dust (75 per cent) and human faeces (25 per cent). Some deem the briquettes

⁴⁷ In Kakuma I the main reason refugees give for selling food rations is to buy other food items (54 per cent of households) and to procure transport (19 per cent), whereas in Kakuma IV it is for milling (34 per cent), to buy other food items (29 per cent), and to buy firewood (23 per cent), with transport only accounting for 3 per cent. UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

⁴⁸ This figure is for the whole camp, not just Kakuma I.

⁴⁹ This is the bulk price. The price per kilogramme is higher when charcoal is sold in smaller volumes.

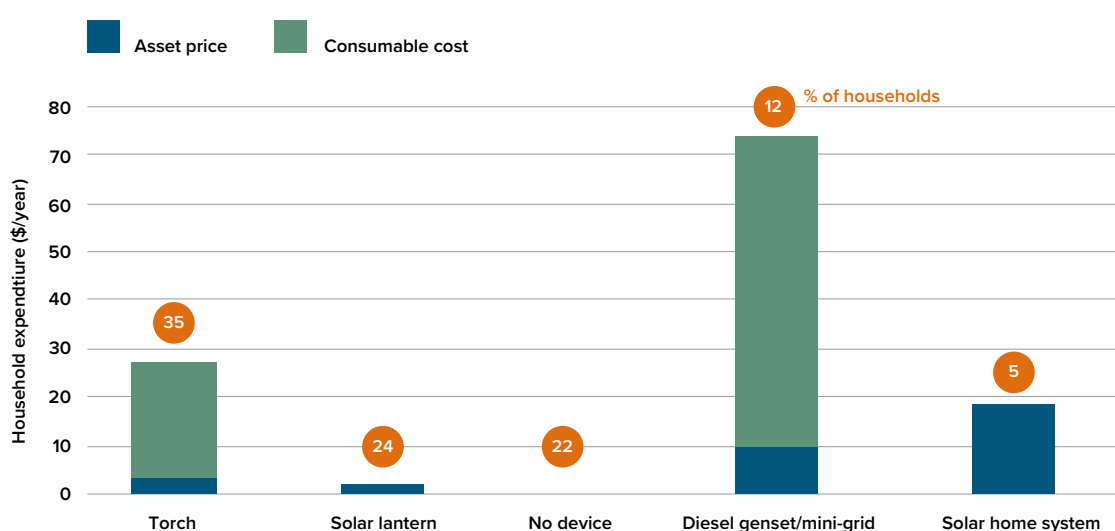
⁵⁰ ENERGYCoP (2017), 'Solar Cooker Distribution', Projects, http://energycop.safefuelandenergy.org/web/energycop/projects/-/project/48859?_it_polimi_metid_energycop_projtech_web_portlet_ProjectPortlet_redirect=%2Fweb%2Fenergycop%2Fprojects%3Fz%3Dxvi6rmxqngnj.

a good alternative to charcoal since they burn longer, but they are not for everybody. One South Sudanese woman explained: 'Sometimes there is a smell to them ... my mother objects to me using the briquettes because of this smell. I cannot use the briquettes and I use charcoal instead.'

Lighting and power

Twenty-two per cent of households have no way to light their home after dark. Low-cost products are available, but higher priorities consume the budgets of the poorest families. Simple torches have replaced kerosene lamps and candles as the preferred option for the majority. Torches are generally brighter, more portable, cheaper and produce no fumes, making them relatively popular, though as a single-point task light they offer limited illumination for a family; moreover, women and children typically have second-rate access to such lights.⁵¹

Figure 6: Prevalence of different household lighting technologies and annual expenditure in Kakuma I



Note: The cost for a diesel generator set/mini-grid is the amount paid by the customer, not by the operator that purchases the generator. Kerosene and candles are used by less than 2 per cent of people. The asset price is levelized according to estimated cost over a five-year product lifetime.

Table 8: Number of hours of light available at night, Kakuma I

Less than 2 hours	36%
2–3 hours	17%
3–4 hours	30%
More than 4 hours	16%

⁵¹ Rom, Günther and Harrison (2017), *The Economic Impact of Solar Lighting: Results from a randomised field experiment in Kenya*.

Torches are classed as providing Tier 0 electricity access; they provide little light and are expensive in the long run. Poor-quality, unbranded torches are dominant in the camp. They can cost as little as \$1, but unsurprisingly have a short life. While actual torches are cheap, the regular purchase of disposable dry-cell batteries is costly. Moreover, in the absence of proper disposal facilities, the thousands of toxic dry-cell batteries discarded by users present a risk of contamination to land and water. Unlike with solar products, a torch's cost increases with usage. This discourages prolonged operation, and torch users typically enjoy fewer hours of light per night.

Figure 6 shows that 78 per cent of households have some form of electric light, ranging from a connection to a mini-grid that powers multiple appliances to a hand-held torch. This still corresponds to low levels of access; 74 per cent of people have Tier 0 and 12 per cent Tier 1 access.⁵² Table 8 shows the very limited number of hours of light available at night for most people. Eleven per cent of respondents also use a secondary light source. Some electrical appliances are in use: phone chargers are common, one in six families has a television, one in six has a radio and one in 40 has a fridge.

Twenty-four per cent of respondent households have a solar lantern with a light, some with a phone charger. In 2014, the Windle Trust distributed 5,000 solar lanterns in Kakuma⁵³ – the model provided was the d.light S2, a small single-point light with integrated panel and battery. Another donor distributed 4,000 solar lights to students;⁵⁴ girls received a solar lantern as an incentive when they reached the first class of secondary school. Some of these torches are now reportedly available in the Kenyan market and command high prices nearing \$20.

The solar lantern market in Kenya is mature, and retailers of both quality-assured and low-quality products can be found even in remote towns such as Kakuma.

The solar lantern market in Kenya is mature, and retailers of both quality-assured and low-quality products can be found even in remote towns such as Kakuma. One shop in the Kakuma camp market and three shops in nearby Kakuma town, one of which is an M-Kopa⁵⁵ franchisee, sell such products. There is high brand recognition among d.light S2 solar lantern owners, who are able to name the brand and model. No solar home system owner was able to name a product brand.

Some 1,700 households in Kakuma I (12 per cent of the total) access electricity from independently operated diesel-powered mini-grids. These are run as businesses, with their owner-operators selling power to neighbours. They typically operate for just a few hours a day and are unregulated, with high tariffs and sub-standard wiring. There are no meters. Operators charge a fixed cost of \$30 per month to serve a shop with basic appliances, and \$5 to supply power to a house with lights and a plug socket. The owners are wealthier refugees – typically male – who have been able to buy generators and establish businesses. Some refugees have switched to solar-powered lighting as it is cheaper than the mini-grid electricity and more reliable.

⁵² Ten per cent have Tier 2, and 4 per cent Tier 3. No one has Tier 4 or 5.

⁵³ ENERGYCoP (2017), 'Emergency distribution of lights in Kakuma refugee camp', http://energycop.safefuelandenergy.org/web/energycop/projects/-/project/48716?_it_polimi_metid_energycop_projtech_web_portlet_ProjectPortlet_redirect=%2Fweb%2Fenergycop%2Fprojects%3Fzx%3Dcizism16p1ns.

⁵⁴ Energias de Portugal, EDP Project in Kakuma, <https://www.edp.com/en/stories/edp-project-kakuma>.

⁵⁵ As of May 2017, M-Kopa has connected more than 500,000 homes to affordable solar power through a mobile-enabled pay-as-you-go scheme.

The mini-grid market is highly territorial, with different suppliers in each quarter of the camp operating as monopolies.⁵⁶ The quarters are largely separated by ethnicity, creating a divide between groups over supply provision. One Somali electricity supplier explained: 'The Ethiopian supplier did not have the capacity to supply to the Ethiopian businesses, so that is why I stepped in. But I cannot connect an Ethiopian household that is not my territory. I would be in trouble! And if any guy connects anyone on my side, I will call the police on him.'

Three filling stations nearby offer diesel at \$1.08 per litre. A black market inside the camp is known to be a source of diesel for many illicit customers. The UNHCR supply may be one source of this low-cost diesel; the organization procures diesel in bulk from Nairobi at \$0.80 per litre (tax free).

Phone charging

Nearly all families own at least one phone, the average being 1.6 phones per family. Sixty-eight per cent of households reported charging their phones for a fee, with 20 per cent charging entirely at home; 12 per cent have no phone. A single charge costs \$0.10, and users charge their devices 3.5 times per month on average.

WFP has introduced electronic cash transfers using a mobile phone platform. Dubbed Bamba Chakula ('get your food' in Swahili slang), this has replaced part of the food ration that the refugees receive each month.⁵⁷ It gives recipients more freedom to select the food they want and lets them buy at a fair price.⁵⁸ 'Sometimes the refugees sell a tin of maize [roughly two kilos] for as little as KES 20 [about \$0.20],' said Mohammed Guyo, a trader in Kakuma camp. 'A kilo of sorghum goes for as little as five shillings.' The market prices of maize and sorghum are much higher than this. This represents a financial loss for the refugees, and also for WFP and its donors. With Bamba Chakula, the refugees receive the full value of their entitlement, and no longer bear the difference in market rates between selling and buying. 'It is a smart move that will benefit us as refugees and as traders,' said Riziki Nadia from Burundi. Mobile phones are essential for the 244 registered traders, who place customers' SIM cards in their devices to carry out transactions (which typically take 10–15 minutes). Traders lure Bamba Chakula customers by providing them with cold drinks and a place to sit as they wait their turn.

Mobile phones also unlock the possibility of introducing pay-as-you-go energy products such as that offered by M-Kopa, though companies may still be reluctant to extend consumer finance to refugees.

Enterprises

Kakuma has a dynamic economy, with busy market places and diversity of commerce and light industry (such as carpentry, tailoring and mechanics) similar to that found in any rural market town in the country. Businesses typically have their own generators or connect to a diesel mini-grid to keep their lights on during the day. Generators also supply heavier loads, such as for maize mills and welding machines. Three solar water-pumping systems for small-scale agriculture and reforestation were installed by a donor.⁵⁹

⁵⁶ Diesel-generator mini-grids are also prevalent in the region, particularly in Somalia given the absence of a national electricity provider.

⁵⁷ Karimi, M. (2015), 'In Kenya, WFP Introduces Electronic Cash Transfers for Refugees in Kakuma Camps', 15 September 2015, WFP via ReliefWeb, reliefweb.int/report/kenya/kenya-wfp-introduces-electronic-cash-transfers-refugees-kakuma-camps.

⁵⁸ Without Bamba Chakula, people sell their food ration for a low price and buy their preferred food at market price. Bamba Chakula is also a more cost-efficient method of supply (for donors) that benefits local companies.

⁵⁹ Energias de Portugal, EDP Project in Kakuma, <https://www.edp.com/en/stories/edp-project-kakuma>.

Community facilities and camp operations

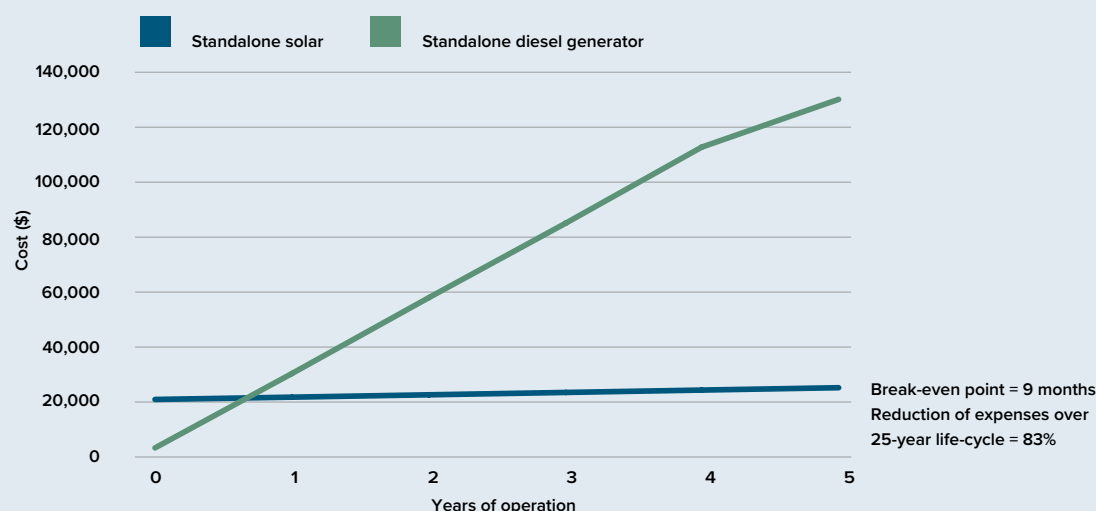
There are an estimated 108 community facilities in Kakuma I: 35 education facilities, three health facilities, four NGO operations compounds, 27 religious facilities and 39 assorted others. Some have a generator, but many operate without electricity. A project by the EDP Foundation installed 47 kW of solar systems and 1,500 low-energy bulbs in 11 buildings.⁶⁰ One NGO compound boasts a solar system that powers security lights, a freezer, fridge, water dispenser and 12 internal lights. Five boreholes have been converted from diesel to solar-diesel hybrid – this saves up to 38 per cent of fuel as well as operation and maintenance costs, while the initial capital investment can be recouped in less than three years.⁶¹

Box 2: An analysis of solar PV water pumping in camps for internally displaced people in South Sudan

In July 2017, the Global Solar and Water Initiative (GSWI) team visited South Sudan to assess selected existing solar pumping schemes, to evaluate the feasibility of solarizing water supply points in selected camps and to raise awareness among water, sanitation and hygiene (WASH) stakeholders in the country.⁶²

The assessment of five water-pumping schemes currently powered with generators alone identified that a standalone solar or solar-diesel hybrid system was preferable in every case. Figure 7 shows that a standalone solar photovoltaic (PV) system in Ajuong Thok camp would break even after nine months and give a reduction in expenses of \$104,000 over five years (and a reduction of \$221,000 over the design life of the system). Considering all five systems, the average break-even point for the solar investment is 1.4 years and the average reduction in life-cycle expenses (capital costs plus operation and maintenance costs over time) is 53 per cent.

Figure 7: Cost analysis of standalone solar PV versus diesel generator water pump in Ajuong Thok IDP camp



⁶⁰ Energias de Portugal, EDP Project in Kakuma, <https://www.edp.com/en/stories/edp-project-kakuma>.

⁶¹ UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

⁶² Global Solar and Water Initiative (2017), 'Visit Report – Refugee and IDP Camps in Maban, Yida and Bentiu – South Sudan, 3rd to 20th July 2017'. Full technical reports are available upon request at solarquery@iom.int.

GSWI concluded that in South Sudan extensive use of solar energy for water pumping is recommended as the period required for investments to break even is shorter than the expected life of the camps.

The cost of diesel is the dominant financial factor in determining the economics of solar water pumping, and South Sudan has some of the highest diesel costs in Africa. A parallel assessment of 20 camps in Sudan, which has some of the lowest diesel costs, yielded an average break-even point of 3.7 years and an average reduction in life-cycle expenses of 55 per cent.

GSWI states that the most significant barrier to successful solarization of water points in the camps is the low solar technical expertise of WASH field teams involved in water supply projects. Insecurity is another problematic factor with solar pumping, suggesting that implementing organizations should undertake case-by-case context analysis for each project before deciding whether to proceed.

Street lights in Kakuma are notoriously prone to being vandalized, with the solar panels and batteries a prize for thieves. One refugee lamented: '[When the light is vandalized] we have to wait for them to repair the light, it sometimes takes a long time. If the light was inside the compound, we would protect it and it would not get vandalized.' Beyond security and mobility, street lighting provides light for studying in quarters with low levels of household access to lighting. One South Sudanese refugee said: 'When you stand in the corner of the compound, you can use the light to read. The children use this light to do their homework.'

Various solar street light projects have been undertaken to illuminate the roads between the compounds; the EDP Foundation has installed 31 units and UNHCR is working with the IKEA Foundation to install 900 more units in the Kakuma camps.⁶³ The initiative will include the installation of 360 units at Kalobeyei Trading Centre, where UNHCR and the host community leadership will work together to identify sites and undertake installation in a bid to promote a sense of project 'ownership' by the community.

Host community

Kenya compares favourably to neighbouring countries in terms of access to energy, though large segments of the population have low levels of access, particularly in the north and in the Turkana region. Thirty-six per cent of the population has access to electricity; 68 per cent in urban areas and 13 per cent in rural areas.⁶⁴ Only 6 per cent of the population has access to clean cooking technologies. The host community is Turkana – traditionally semi-nomadic pastoralists – with typically low incomes and low levels of energy access.

Kakuma town is not served by the national grid, which is some 200 kilometres away. However, the Rural Electrification Agency is building a diesel mini-grid for it. This is being eagerly awaited by town residents, humanitarian agencies and refugees alike. Kenya has a mature and innovative off-grid energy market, with leading technologies and companies such as M-Kopa, d.light and BBOX proving successful.

⁶³ UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

⁶⁴ SE4All Global Tracking Framework 2017.

4. Refugees' Energy Priorities

Little is known of refugees' preferences and priorities in relation to access to energy. Too often humanitarian agencies, donors, camp management and other actors prescribe solutions without engaging with their users. Handouts of energy products that do not satisfy user needs or are not culturally acceptable limit the sustainability and impact of initiatives, and compel refugees to find other means of meeting their needs at greater cost. For example, there are many cases of unwanted cookstoves or solar products being thrown away, sold or adapted for other purposes. Clear engagement with refugees is important for gauging demand and creating a sense of ownership among end-users of energy products and services.

Needs assessment is not without pitfalls, however. Care is required to ensure that asking refugees about their priorities does not raise unrealistic expectations of receiving improved energy access and solutions. Donors and programme designers need to balance refugees' wants with limited budgets, mandated international standards and other pressing factors.

This chapter presents refugees' energy priorities, preferences, and willingness to pay for different products and services – it draws on data obtained through household surveys in Goudoubo and Kakuma I.

Goudoubo

Table 9: Refugees' priorities for improvements to energy access in Goudoubo

	Priority 1	Priority 2	Priority 3
Street lighting	42%	24%	12%
Energy for households	37%	20%	13%
Energy for health facilities	12%	23%	25%
Energy for schools	2%	16%	29%
Energy for businesses	4%	9%	15%
Energy for government buildings	3%	8%	5%
Energy for agricultural needs	0%	0%	2%

Note: Refugees were asked to rank their top three priorities in response to the question: 'Thinking about the community as a whole, what are the most important energy needs that should be addressed?' Responses are aggregated for men and women.

Table 9 shows that street lighting is the priority for improvements for refugees in the camp (the survey was conducted when there were no street lights in Goudoubo).⁶⁵ 'Security and safety' is listed as the first reason why lighting is important (Figure 8).

The provision of widespread street lighting is a major investment; a small camp such as Goudoubo has about 5 kilometres of main roads, and the necessary street lighting would cost in the region of \$150,000 to install.⁶⁶ Solar street lights have a notoriously high failure rate, with theft of panels and poor maintenance common issues. Working closely with refugee groups to promote a sense of custodianship – and thus a readiness to look after communal facilities – is important for ensuring the longevity of street light installations. One approach is to give responsibility for maintenance to refugee groups (as is the practice with water pumps); another is for communities to select the sites that they consider important and can protect.

Despite high rates of ownership of solar lanterns and basic cookstoves, a large proportion of respondents cited increased access to energy for households as a priority issue for improvement. Energy for the health clinic, schools and enterprises were listed as second-tier priorities. Women and men ranked their priorities similarly, though women placed household energy slightly ahead of street lighting, and men vice versa.

Table 10: Ranked importance of energy uses in the home, Goudoubo camp

	Priority 1	Priority 2	Priority 3
Mobile phones	37%	30%	24%
Electric lighting	30%	15%	17%
Radio or television	8%	31%	27%
Making things/doing work	8%	10%	17%
Pumping water	9%	10%	9%
Cooking food and making hot drinks	7%	0%	3%
Refrigeration or preservation	1%	3%	4%

Note: Responses are aggregated for men and women.

Table 10 shows that mobile phones and lighting are the priority energy uses in the home. This implies that the technology offering best value for money in terms of meeting refugees' priority needs consists of solar products with light and phone charger. The high cost of grid connection and household wiring will not be justified if the electricity is used only for lighting and phone charging. Mobile phones are valued for communicating with friends and family in neighbouring Mali.

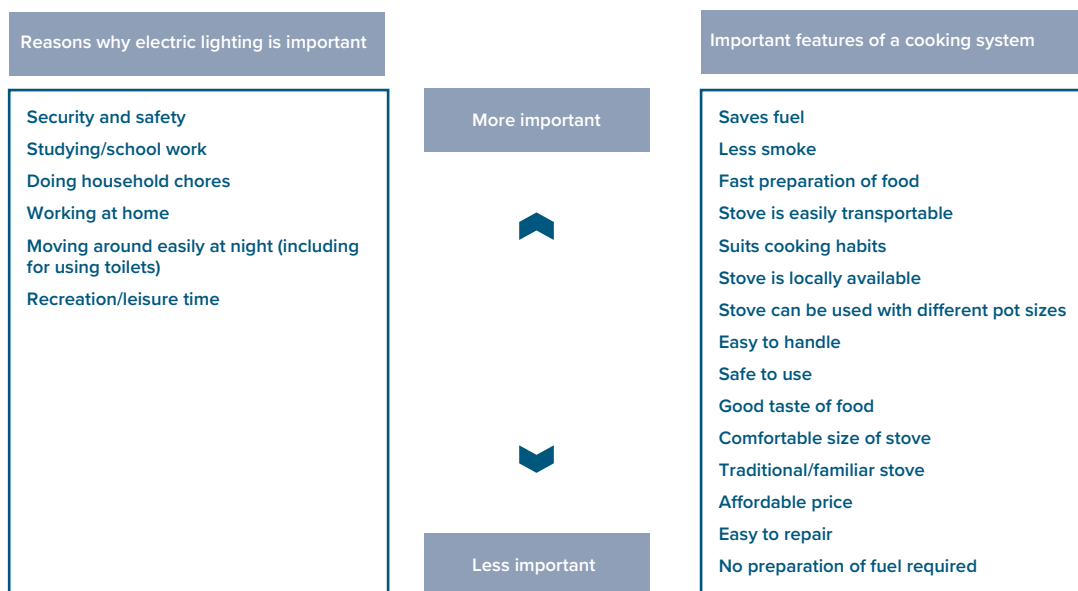
⁶⁵ There are now 80 solar street lights in the camp, funded by the IKEA Foundation.

⁶⁶ A solar street light costs about \$1,500. Reasonable coverage would place lights along main roads, at dense clusters of shelters and at principal facilities such as toilets. This cost estimate assumes one street light positioned every 50 metres along a main road.

Radio and television are also high on the list of priorities, reflecting the desire for entertainment and news on current affairs. Despite the apparent demand, these technologies rarely feature in humanitarian projects. The links between entertainment/information appliances and urgent human development indicators are more tenuous; furthermore, solar home systems that power televisions represent a significant step up in terms of cost and complexity.

Perhaps surprisingly, cooking food rated as a low priority for women and men alike, suggesting a methodological weakness in the survey; perhaps respondents interpreted the question as 'What are the priority *electricity* uses in the home?' rather than considering energy more holistically. The central role of food and cooking in people's lives means this is likely to remain a priority intervention area.⁶⁷

Figure 8: Important features of electric lighting and cooking technologies identified by respondents in Goudoubo



Note: Responses are aggregated for men and women.

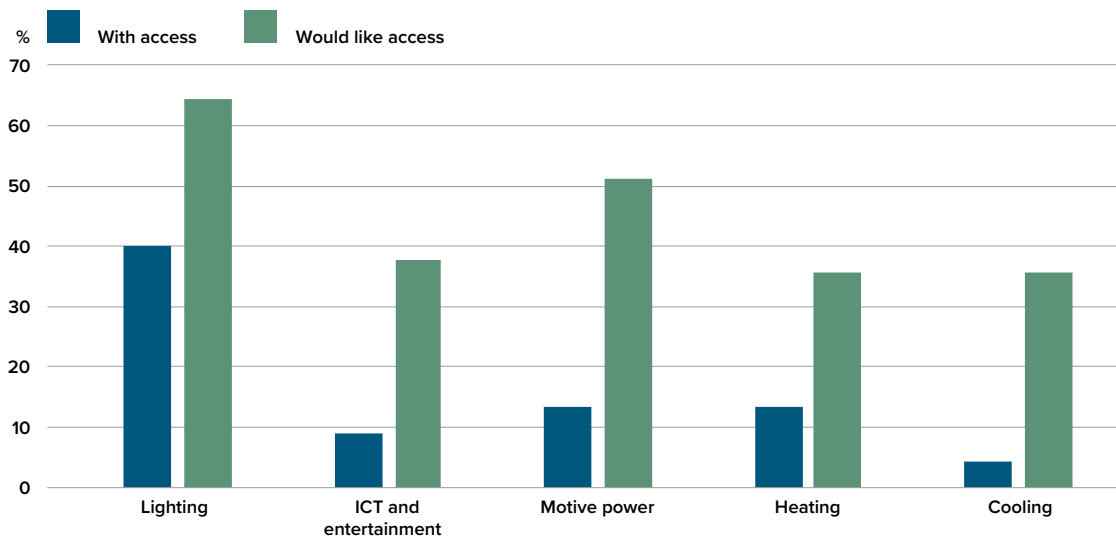
The ranking of the features of cooking systems in Figure 8 shows that camp residents consider fuel savings as the most important. This finding needs to be interpreted carefully, however; the zero-fuel solar cookers that were introduced to the camp proved unpopular. Speed of cooking, portability and cooking habits remain deal-breakers when it comes to stove acceptability. Men and women have slightly different priorities: although both ranked fuel savings as the most important feature of a cooking system, women valued systems that produce less smoke more highly than men did.

Figure 9 shows that entrepreneurs identified a significant energy access deficit as a constraint on economic activity. Sixty per cent of enterprises don't have access to lighting, and one-quarter indicate they would like to have it to extend shop opening times or home activities such as

⁶⁷ The Global Alliance for Clean Cookstoves provides a strong evidence base for the importance of clean cooking. See www.cleancookstoves.org.

leatherwork. Street lighting in the market was also suggested as a necessary provision. 'If we had enough energy, we would open shops and restaurants that stay open at night, and we would set up milk shops that use refrigerators,' said Fadimata Wallet Haibala, chair of the women refugees' committee and a member of one of many families keeping livestock for milk production or meat sales. Farmers noted that water pumping is necessary to expand the cultivable land and growing season, while power tools would increase productivity. Encouraging agriculture would promote employment and food security.

Figure 9: Enterprise access to energy services in Goudoubo



The head of the camp's refugee executive committee stressed the need for financial support and technical assistance alongside improved energy access. For example, there is interest in solar energy educational programmes for refugees to develop skills and knowledge to take with them when they leave the camp.

Figure 10: Community facilities' access to energy services in Goudoubo

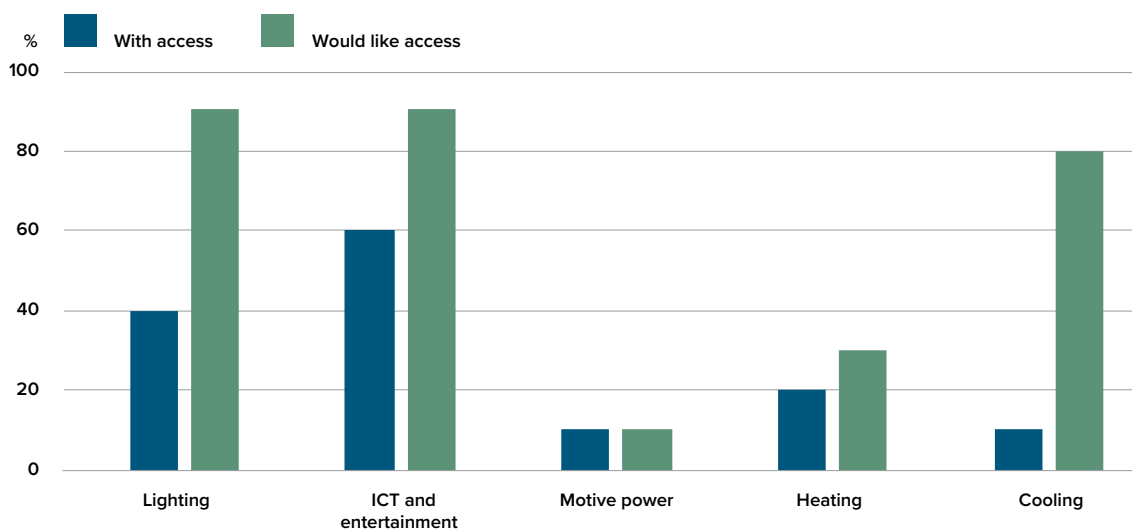


Figure 10 shows near-universal demand for lighting, powering computers and charging phones. It also shows very high untapped demand for energy to power electric fans or air conditioners in the clinic, schools and administrative buildings. Only a few facilities are currently able to meet these needs. At the time of the survey, the clinic had a diesel generator, but its hours of operation were limited to reduce operational costs. Small solar systems provided limited supply to other facilities.

Installing a solar pump to replace the two inefficient and costly diesel-powered water pumps was mentioned as a priority in interviews.⁶⁸

Kakuma I

Table 11: Refugees' priorities for improvements to energy access in Kakuma I

	Priority 1	Priority 2	Priority 3
Energy for households	37%	21%	23%
Energy for health facilities	17%	21%	19%
Energy for schools	17%	18%	21%
Street lighting	18%	18%	17%
Energy for businesses	7%	14%	11%
Energy for agricultural needs	3%	5%	4%
Energy for government buildings	2%	3%	5%

Note: Refugees were asked to rank their top three priorities in response to the question: 'Thinking about the community as a whole, what are the most important energy needs that should be addressed?'. Responses are aggregated for men and women.

Energy in the home stands out as the clear priority for improvement for women and men in the camp (Table 11). Evidently, families are tired of spending a lot on energy and recognize that better and cheaper solutions are attainable.

The clinics and schools in Kakuma I have relatively high levels of electricity access, with many buildings receiving a basic power supply from solar systems or diesel generators. Still, one-third of survey respondents said that this should be the focus of energy improvements.

Street lighting is the priority for nearly one-fifth of respondents, reflecting the fact that Kakuma I has some street lighting but that street lighting is not present throughout the camp. UNHCR is expanding coverage, however. It has identified the schools, health centres, water-pumping stations, public places such as the market, and areas around the communal latrines and showers as locations where public lighting would have a positive impact.

⁶⁸ In Dadaab camp in Kenya, solar water pumps provide about 10 per cent of the water supply, pumping 1,285 cubic metres per day and saving more than 10,000 litres of diesel per month. UNHCR (2016), *Kenya Comprehensive Refugee Programme 2016*.

Table 12: Ranked importance of energy uses in the home, Kakuma I

	Priority 1	Priority 2	Priority 3
Mobile phones	44%	27%	16%
Radio or television	18%	26%	14%
Making things/doing work	7%	8%	24%
Electric lighting	7%	15%	16%
Cooking food and making hot drinks	6%	7%	11%
Heating water and washing	4%	5%	7%
Processing crops/foodstuffs	6%	5%	8%
Pumping water	7%	7%	4%

Note: Responses are aggregated for men and women.

Table 12 shows charging mobile phones as the most important form of energy use in the home, topping the list of refugees' priorities by a wide margin. A high proportion of males use a mobile phone's light for studying after dark. Phones are charged on average 3.5 times per month; 73 per cent of users said they would use phones more often if they could charge them more easily.

Radios and television are the second-most important energy technology, surprisingly ranking above electric lighting and cooking. This suggests that larger solar home systems or micro-grid connections are necessary to meet demand.

When asked the most important features of a cookstove, respondents' top answer was that it should produce less smoke. This came above fuel savings, showing the severity of the health problems that refugee families perceive as resulting from the inhalation of smoke. In this, the refugees' priorities align with humanitarian goals.

Figure 11: Enterprise access to energy services, Kakuma I

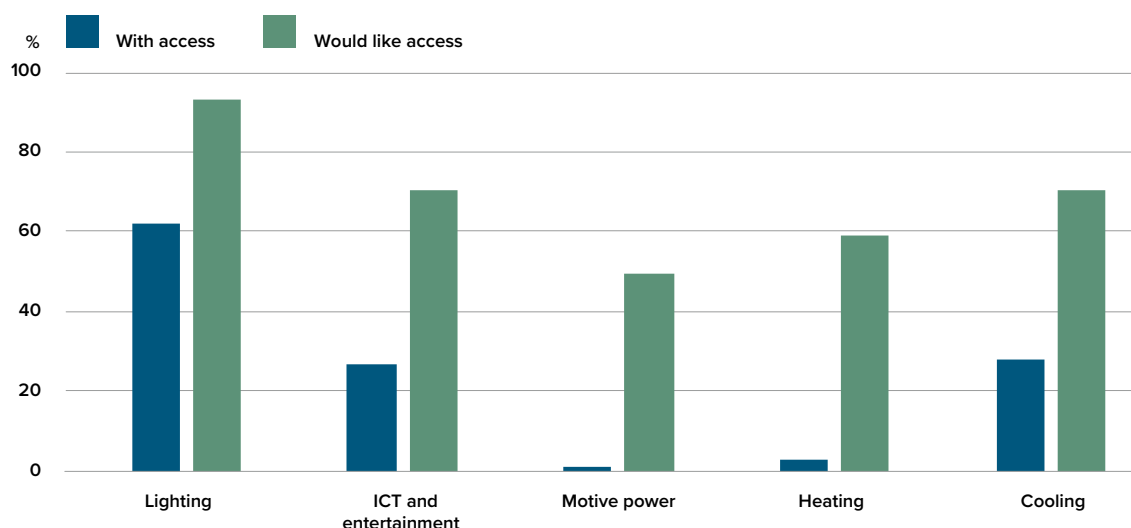
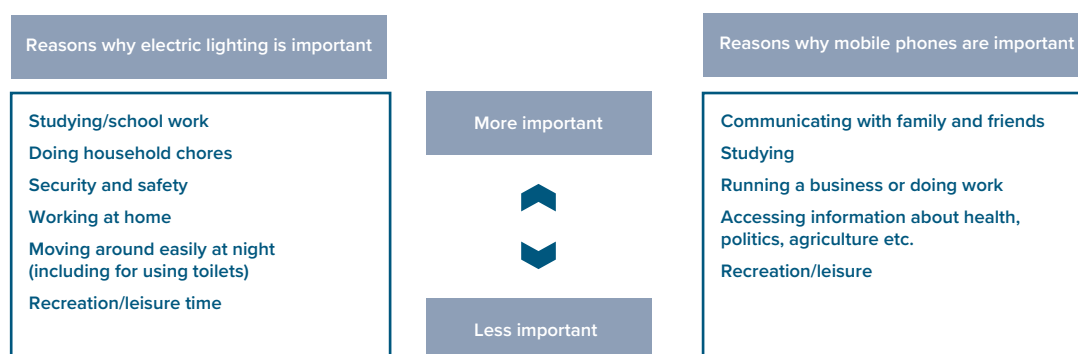


Figure 11 shows that virtually all enterprises would like better lighting. One Somali businessman said: 'Competition is high, I want my customers to come to me and my store. They see the light, they know I am here, and they are welcome.' Ownership of refrigerators, freezers, televisions and radios is low, though there is high demand for these appliances from restaurants and shops. Maize mills, mechanics and carpenters also wished for an affordable electricity supply. This latent demand is a precondition for a successful micro-grid, where enterprise consumption is a cornerstone of the business case.

Many refugees noted that affordability of appliances and availability of business finance are significant barriers to increased energy access. Projects promoting energy for productive use typically include components of financial inclusion and business development alongside an improved energy supply.

Figure 12: Important features of electric lighting and mobile phones identified by respondents, Kakuma I



Note: Responses are aggregated for men and women.

5. Energy Access Scenarios: Options for Reducing Costs and Improving Lives

Clearly there is dissatisfaction both among refugees and humanitarian agencies with the current level of energy provision in the camps. Expensive and dirty technologies are proving inadequate, and there is demand for change. What solutions are promoted and who receives access at what cost are key questions as the humanitarian sector reforms its approach to energy delivery. This chapter provides a picture of the energy economics associated with achieving certain targets, with a focus on capital and operating requirements as well as on savings relative to a business-as-usual baseline. To do so, it presents scenarios for improved energy access for Goudoubo and Kakuma I respectively, with the aim of informing the debate in the two camps and beyond. The scenarios are intended to open a discussion on the potential interventions and level of finance required to achieve the desired results.

Two of the scenarios have been defined using refugee survey responses on preferred technologies and willingness to pay, and thus give valuable insights into market demand. Respondents were asked to choose options from a set of information cards (with product photos and specifications) based on pre-selected technologies deemed to be appropriate. Each scenario describes the mix of energy solutions and the associated cost (for each user and the camp as a whole), using the 'levelized cost' of energy values (see Box 3). The three scenarios consider energy access for households, enterprises and community facilities. Annex 1 details the survey methodology and data-analysis techniques. The scenarios have been developed for (a) cooking and (b) light and power in the two camps.

Scenario 1: User preference

This scenario reflects provision of the levels of energy access that refugees say they want. The cooking solution was defined by asking refugees their preferred cookstove and fuel combination. The electricity solution was defined by asking refugees what electrical appliances they would like and how many hours' use they need. The respective overall costs of providing these levels of access via (a) a centralized supply – either a mini-grid or connection to the national grid – and (b) decentralized technologies were then compared. Respondents were not informed of the price of each option.

Scenario 2: Willingness to pay

This scenario presents the levels of energy access that refugees have indicated they are willing to pay for. The cooking component of the scenario was defined by asking respondents if they were willing to pay for their preferred choice (as defined in the 'User preference' scenario). If they were not, they were asked about their willingness to pay for lower-ranking options until a match between preference and willingness to pay was identified. If no match was found, the

three-stone fire was allocated as the default cooking option. For electricity, respondents were asked what they would be willing to pay for each option; they were then assigned the highest-tier option for which the amount they were willing to pay matched or exceeded the cost. The price of each option was presented to respondents as a levelized cost (a daily cost equivalent) in order to have a single point of comparison (rather than comparing both the capital cost and operating cost). For the equivalent to the levelized cost to be made available to the user in reality would require the provision of consumer finance on appropriate terms.

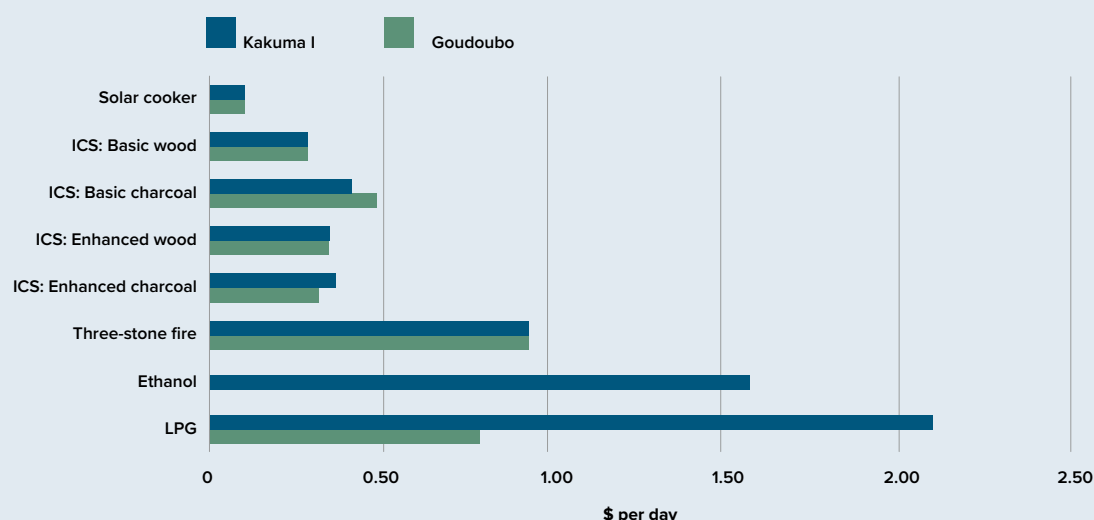
Box 3: Levelized cost of energy

Levelized cost of energy (LCOE) is a useful measure to compare different energy technologies, some of which have high purchase costs and some of which have high fuel costs. It incorporates the purchase price of the device and ongoing expenditure on fuel to give a like-for-like value that can be used to compare the costs associated with different technologies. The LCOE for cooking is calculated using the formula:

$$\text{LCOE for cooking} = \text{fuel use (\$/day)} + \text{stove cost (\$/stove life (days))}^{69}$$

This study calculates the LCOE for cooking on the basis that 100 per cent of the fuel consumed is bought at the local market price (see Table 19 in Annex 1). For cooking, this effectively monetizes the full cost of fuel, incorporating efforts of the individuals (who spend hours and much exertion collecting fuel), the value of the fuel ration and the food traded for fuel. This is an important theoretical measure for the humanitarian community, but may not reflect the reality of the daily finances of refugees. The LCOE does not capture externalities (such as health impacts, local environmental degradation or carbon emissions). The costs associated with introducing a new stove or electricity service/product (such as project development costs) are assumed to be covered by capital costs.

Figure 13: Levelized cost of energy of different cooking options



⁶⁹ No discount rate was applied for LCOE for cooking given the negligible influence of stove cost on value. A discount rate of 15 per cent was used for electricity LCOE calculations.

The prices of wood and charcoal in the two camps are comparable, though prices vary significantly according to season, quantity purchased and quality. In Goudoubo, cooking with LPG costs \$0.79 per day – roughly double the price of improved cookstoves – but it is the only available clean cooking solution that meets international health standards.⁷⁰ It is important to note the low cost of LPG refills thanks to government subsidies, though there are periods of unavailability in Goudoubo; this is not the case in Kakuma I.

The LCOE values indicate that the basic and enhanced cookstoves are low-cost options. The basic improved cookstove (ICS) has an LCOE of \$0.29 per day – the cost of the stove itself is low but fuel use is high. The enhanced ICS is much more expensive in terms of purchase cost, but has a longer life and uses less fuel. Its LCOE is therefore comparable to that of the basic ICS.

The high cost of cooking on a three-stone fire is striking: at \$0.93 per day, its LCOE is three times greater than that of a basic ICS. This reflects the inefficiency of the three-stone fire,⁷¹ as well as the methodology's assumption that 100 per cent of the fuel is purchased. In reality, only a proportion of wood fuel is purchased; the baseline survey showed that households cooking on a three-stone fire spend \$0.22 per day on wood in Goudoubo and \$0.16 per day in Kakuma I. These figures do not include the amount UNHCR spends on fuel handouts, the value of food rations people trade, or the amount of time women spend gathering firewood. The prodigious wastage of a three-stone fire is evident when the full economic cost is considered.

Solar cookers appear extremely competitive: their high initial purchase price is soon offset by the sun's free power. The low acceptability of the technology, however, makes it a false economy; people soon switch back to dirty and inefficient stoves.

The electricity scenarios also calculated an LCOE value based on the preliminary design and costing of a generation and distribution system (including capital and operating costs) for each level of energy access. Average and maximum daily electrical demands were calculated and aggregated across the community using survey inputs to inform the model. Annex 1 provides more detail on the methodology.

Analysis of refugees' willingness to pay for different levels of energy access gives interesting insights into their preferences and perceptions of value, but it has limitations. Prices vary due to technology change, business innovation or foreign-exchange fluctuations, and this can reduce the accuracy of results. In addition, responding to a survey question is not the same as actually making a purchase. This gap can affect results – for example, if respondents 'game' the survey in the expectation that their response could affect prices or if their product knowledge is poor.⁷²

⁷⁰ According to the World Health Organization.

⁷¹ The LCOE calculation assumes a three-stone fire efficiency of 10 per cent (though a well-tended fire in favourable conditions with dry wood may have an efficiency of 20–30 per cent).

⁷² Though respondents were shown information cards to raise their awareness and clarify technology options.

Scenario 3: Total Energy Access

The 'Total Energy Access' scenario – an approach developed by Practical Action⁷³ – is not defined by refugee survey results but by the principle that every household, business and community facility should have some access to modern energy. Different levels of access – i.e. different types of energy technology – are assigned to reflect the range of needs and ability to pay. For this study, the access levels allocated attempted to reflect camp realities but were not based on a detailed design.⁷⁴ Rather, they assumed an aim of ensuring that every family has access to a minimal level of energy services, and that higher-income households have the opportunity to use more and higher-power appliances. In this scenario, a small number of businesses with heavier demand for power are able to operate while businesses requiring less power also benefit. Clinics and schools are able to power basic and specialist equipment, and administrative buildings can power laptops and mobile phones. The scenario provides for each camp to have extensive street lighting and a pumped water supply.

Cooking in Goudoubo

As Figure 14 shows, the '**User preference**' scenario reflects the diversity of refugees' preferences, with seven different types of stove chosen. A project seeking universal stove coverage would need to consider this wide range of needs. Three-stone fires are the preferred choice for just a small minority of respondents, despite nearly one-third still using this method. This indicates that the barrier to cleaner cooking is not consumer preference: there is a clear desire among refugees to adopt clean cooking solutions if financial considerations permit. LPG is the preferred option for one-fifth of respondents, and enhanced stoves are the choice for half.

The '**Willingness to pay**' scenario shows what happens when preferences meet price considerations. A large proportion of households – about half – would still adopt a higher-standard stove. The camp population would adopt a mix of basic stove, enhanced wood and charcoal stove, as well as LPG if this technology were available and could be purchased on finance. The model allocates the three-stone fire option to one-third of respondents, as they did not express a willingness to pay for their preferred stove. This 'affordability gap' defines the amount of subsidy that would be required to encourage the camp population to move away from the use of three-stone fires.

Three other scenarios have been defined without inputs from refugees: '**ICS: Basic wood**', '**ICS: Enhanced wood**' and '**Clean cooking**' (see Figure 15). They represent the typical targets of stove projects and serve as an interesting comparison.

⁷³ Practical Action promotes a Total Energy Access approach in which households, enterprises and community facilities have access to the full range of energy services they need. This scenario has only been modelled for light and power. See <https://policy.practicalaction.org/policy-themes/energy/total-energy-access>.

⁷⁴ For example, the figure for grid connection was determined by only allocating this level to fixed shelters that can meet national wiring standards, or to enterprises with a clear demand for grid power (not to farmers, for example).

Figure 14: Cookstove technologies per scenario, Goudoubo

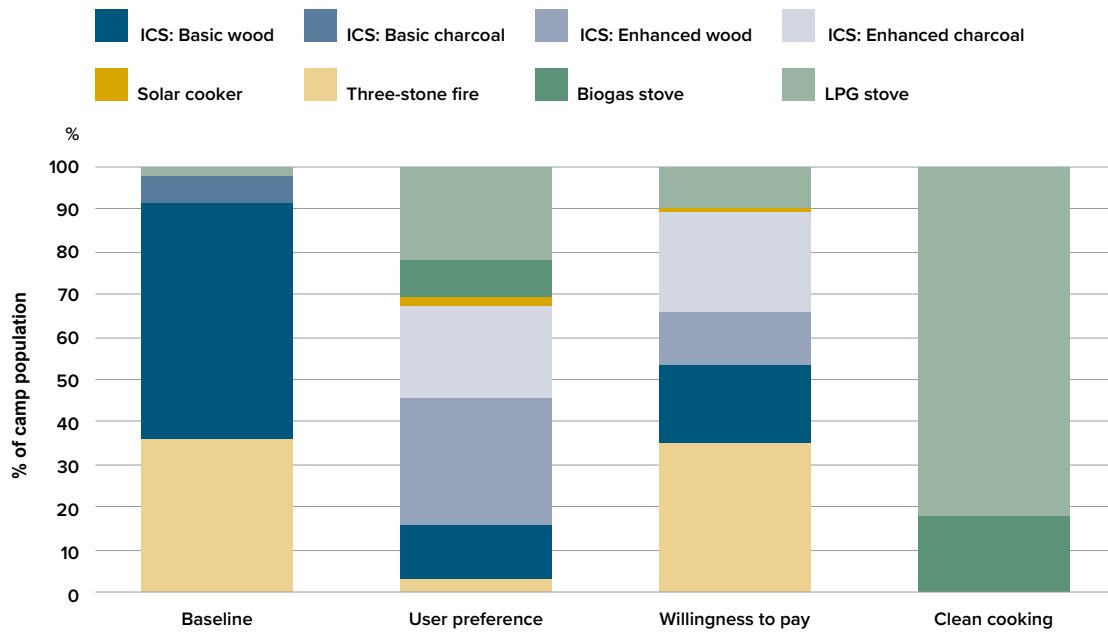


Figure 15: Daily levelized costs of cooking energy scenarios in Goudoubo

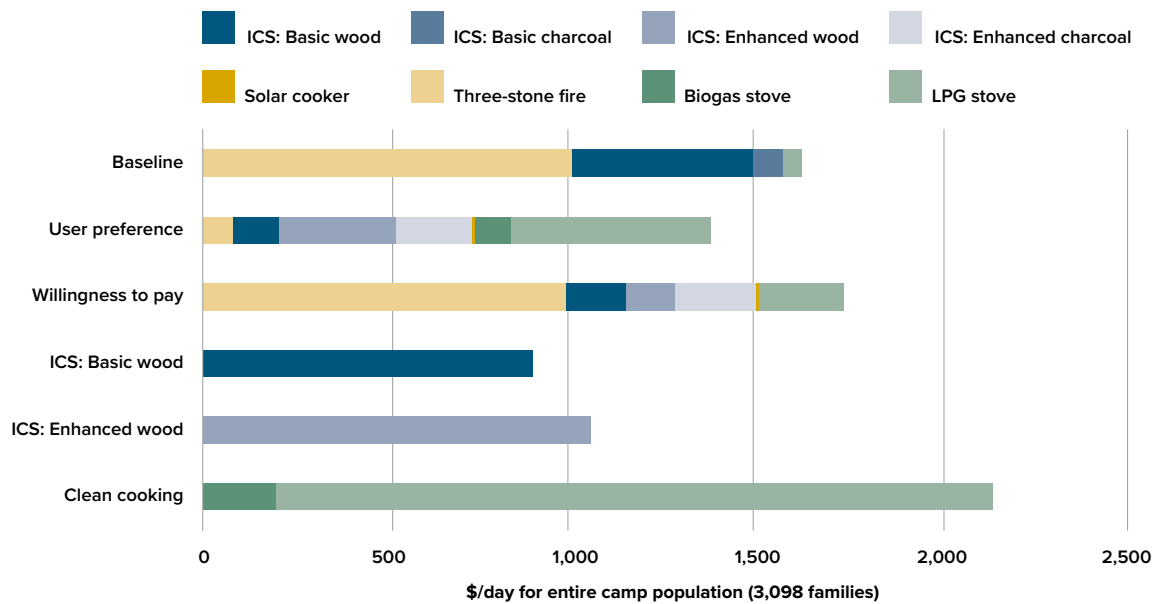


Figure 15 shows that realizing the **'User preference' scenario** would cost \$1,400 per day for the entire camp, or \$0.5 million per year, slightly lower than the aggregated LCOE of the **'Baseline' scenario**. The **'User preference' scenario** represents a significant improvement in cooking technologies in the camp, and would yield a range of health and social impacts. The fact that the result is defined by the target group implies that a programme that delivered these outcomes

would be welcomed, and would have enhanced impact and sustainability. It does, however, leave a small proportion of people with the lowest level of access. Awareness raising or marketing activities may alter the perceptions of this group to create demand for improved cookstoves.

Two-thirds of the camp are willing to pay for cookstoves, at a total cost of \$750 per day, or \$0.27 million per year. The **'Willingness to pay' scenario** represents a high-impact, low-cost opportunity, though to achieve universal access would require a subsidy for the one-third not willing to pay. Counter-intuitively, this scenario has a higher cost than the **'User preference' scenario**. This reflects the fact that the model sets the three-stone fire as the default option for families not willing to buy a stove, even though the LCOE value is high.

To achieve a universal **'Clean cooking' scenario**, with a mix of LPG (82 per cent) and biogas (18 per cent), that meets global health standards would cost \$2,140 per day or \$781,000 per year. Targeting 100 per cent basic ICS usage would cost around \$900 per day, whereas 100 per cent enhanced ICS usage would cost just over \$1,000 per day. Counting the health and environmental benefits would make the additional \$100 or so per day a worthwhile investment.

Box 4: Cost–benefit analysis for analysing cooking economics

Cost–benefit analysis is an alternative method to LCOE that compares the financial and non-financial costs and benefits of cooking solutions. A net calculation of costs and benefits is calculated using a monetary estimate of economic, social and environmental factors such as:

- Additional refugee income enabled through time saved in collecting fuel and cooking;
- Health problems mitigated;
- Greenhouse gas emissions mitigated; and
- Local land degradation mitigated (or reduced need for afforestation programmes).

Other costs and benefits, such as reduced sexual and gender-based violence or better access to education, are notable but not monetized in cost–benefit analysis (they are inherently harder, and more controversial, to quantify).

A recent cost–benefit analysis of a refugee camp in Tanzania by UNEP DTU⁷⁵ (a United Nations Environment Programme and Technical University of Denmark partnership) showed that over a 10-year period, an LPG intervention would cost \$397 per capita and yield a benefit of \$700 per capita.⁷⁶ Further analysis showed that the intervention had a positive net present value and a high internal rate of return.

A key feature of a cost–benefit analysis compared to a financial analysis is the choice of the stakeholders affected by the intervention. The UNEP DTU analysis included the costs and benefits affecting all agents (refugees and UNHCR) and thus included the opportunity cost of time lost, for example. On the other hand, a financial analysis would consider solely the UNHCR perspective.

⁷⁵ Rivoal, M. and Haselip, J. (2017), 'The true cost of using traditional fuels in a humanitarian setting. Case study of the Nyarugusu refugee camp, Kigoma region, Tanzania', UNEP DTU Partnership, Technical University of Denmark.

⁷⁶ Using a 3 per cent discount rate.

Light and power in Goudoubo

The **'User preference' scenario** shows that 100 per cent of the camp's population would like the level of electricity access that a reliable grid connection could provide (Figure 16). They would also like a range of electrical appliances. A stated demand exists for power for households, enterprises, community facilities and street lights. Virtually all respondents indicated a desire for at least a few lights, a phone charger and entertainment; 61 per cent wanted additional appliances and the ability to use them throughout the day (Table 13). Respondents were assigned an electricity access tier based on the appliances they would like and the amount of usage they wished to have.

Table 13: Electricity access tier desired by refugees in Goudoubo

SE4All tier	Indicative appliances available at tier	% of households
0	Single light or no device	0
1	Minimal light, charger	0
2	Multiple lights, charger, efficient television, radio or fan	38
3	Tier 2 + electric fan, fridge, etc.	61
4	Tier 3 + more appliances and usage	0
5	Unlimited use	1

The 'User preference' scenario is based on a connection to the nearby national grid,⁷⁷ with each household receiving a metered connection as an individual customer and the tier level of supply indicated in Table 13. The scenario calculates a maximum demand of 1 MW and an annual consumption of 1,500 MWh. Figure 17 shows the capital cost of this at \$1.8 million and the annual running cost at \$0.4 million in grid tariffs.

The **'Willingness to pay' scenario** shows that only one-quarter (see Figure 16) of people would use grid electricity if they had to pay the consumer tariff⁷⁸ (a grid tariff of \$0.17 per kWh and a small annual charge are applied). Many refugees expressed a desire to have a technology that they could take with them once they leave the camp, and thus had little interest in investing in the upfront installation costs of connecting their homes to a grid. There was also some concern that the shelters were not suitable for high-voltage electrics since tent materials can melt, livestock tend to chew wires and there are no trained electricians. Indeed, the grid regulator would not deem tents safe and would prohibit connections.

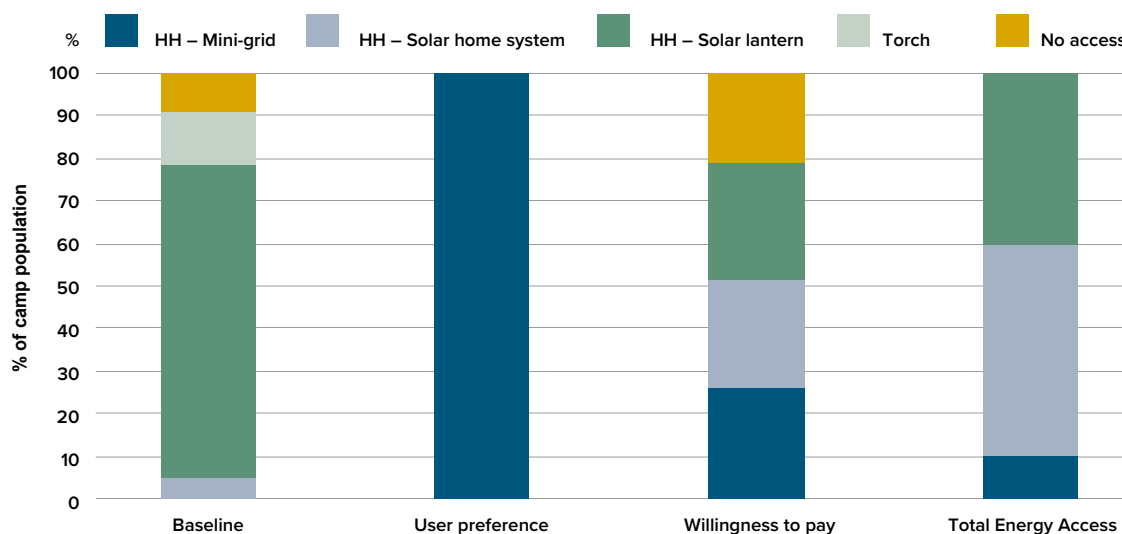
One-quarter of people are willing to pay for a \$10 solar lantern (a small task light) and one-quarter for a \$126 solar home system (with multiple lights and charger). This equates to a market value in excess of \$100,000 – a promising sign for companies seeking to sell quality products to refugees. This leaves one-fifth of people who indicated that they are not willing to pay for a quality device.

The 'Willingness to pay' scenario entails a \$0.66 million capital subsidy and \$84,000 annually in grid tariffs (Figure 17). This is based on peak demand of 210 kW and annual consumption of 300 MWh.

⁷⁷ When the national grid is nearby and connection is possible, this is highly likely to be the most economical solution.

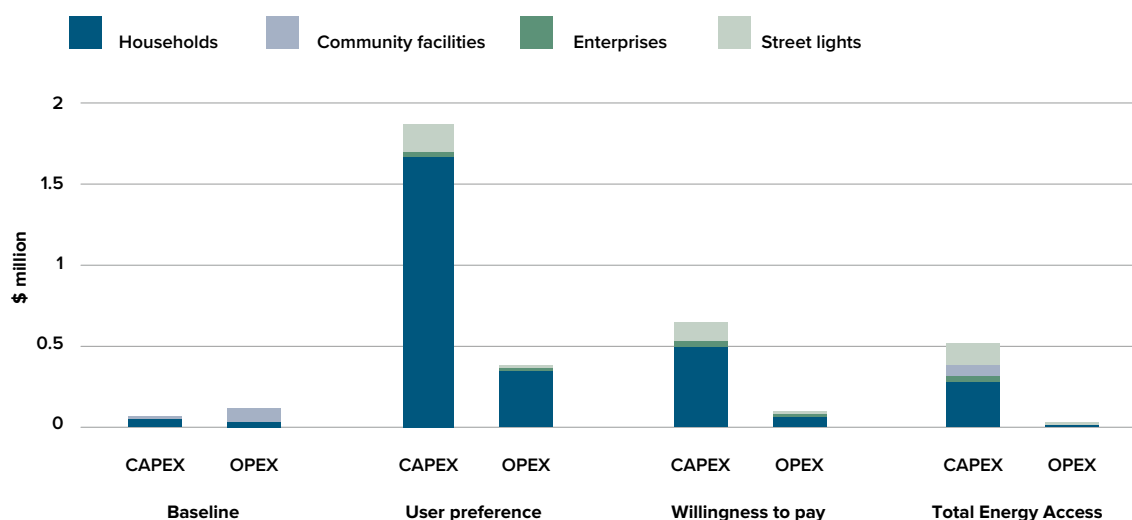
⁷⁸ The capital cost is assumed to be investment by UNHCR; repayment on capital is not included in the willingness-to-pay measure.

Figure 16: Light and power scenarios: refugees' access to different supply technologies, Goudoubo



Note: The levels of access for enterprises and community facilities are not indicated.

Figure 17: Light and power scenarios in Goudoubo – capital expenditure (CAPEX) and operating expenditure (OPEX)



The **'Total Energy Access' scenario** is not defined by refugee input but by the principle that every household, business and community facility should have access to modern energy. It assigns a Tier 2 grid connection to 10 per cent of households, a solar lantern set (multiple lights and charger, Tier 1) to 50 per cent, and a solar lantern (single light and charger, Tier 0) to 40 per cent.⁷⁹ This meets the basic needs of all refugees in a cost-efficient manner.

⁷⁹ The proportion allocated to each supply option loosely reflects the spread of income among the camp population. The number of houses with grid connection is limited by the number of fixed shelters; makeshift shelters of wood and sheet do not meet grid regulation wiring standards.

The clinic, schools and operations buildings have grid electricity, as do the street lights and water pumps. A small number of enterprises requiring high-power appliances have grid connection, though most have a solar lantern set. A centralized grid connection in place of the current ad hoc and piecemeal supply would create savings and impact.

Box 5: Connecting refugee camps to the national electricity grid – key issues

Political economy: Host countries in sub-Saharan Africa typically have weak grid systems with insufficient generating capacity and low rates of grid access. Prioritizing the needs of refugees over those of host communities is politically unpopular. The permanence suggested by a grid connection is also politically unpalatable when governments are reluctant to grant long-term status and rights to refugees.

Capital finance: Who pays for the major capital items – transmission, transformer sub-station, distribution and household wiring – will likely depend on negotiations between UNHCR and the grid operator (and perhaps with refugees too in the case of wiring).

Ownership and maintenance: Camp administrators could assume responsibility for the distribution grid (purchasing electricity on a bulk-supply basis and managing relationships with individual customers). Alternatively, the grid operator could assume full responsibility up to point of use.

Tariff and charges: The tariff for consumption and fixed charges will depend on the supply arrangement, power and energy demand, and how the operator defines the types of users. If the camp arranges a bulk-supply purchase, it could set a tariff independently.

Negotiations and agreement: The complexity of permutations of the above requires specialist expertise to undertake the negotiations and finalize agreement.

This scenario has a capital cost of \$0.52 million and annual running costs of \$32,000 in grid tariffs. Figure 18 shows that supplying the 3,098 households takes up the greatest proportion of the capital, with street lights also requiring a major investment. The peak demand is 51 kW and annual consumption is 133 kWh per year. Provision of different levels of electricity access among the camp population through handouts would be inequitable and divisive. Instead, a market-based solution in which individuals selected and purchased their preferred product could realize this scenario.

The three scenarios – ‘User preference’, ‘Willingness to pay’ and ‘Total Energy Access’ – represent dramatic improvements in the level of electricity access in the camp. If realized, they would offer a positive social impact and unlock economic activity. However, implementation would require high capital inputs: grid connection, distribution and wiring are expensive.

To deliver the higher level of access in the ‘User preference’ and ‘Willingness to pay’ scenarios would entail higher operating costs for all users than under a business-as-usual baseline scenario. Despite the relatively low grid tariff, the demand for electrical appliances still exceeds the amount currently spent on diesel generators and torches (taking note that a large proportion of residents use solar lights). This indicates that increased access to electricity could unlock a wide range of social and productive energy uses, facilitating a step change in the well-being and economic self-sufficiency of the camp.

The 'Total Energy Access' scenario offers a saving in terms of operating costs compared to the baseline that presents a financial opportunity, however marginal. Table 14 shows that the realization of this scenario would provide an annual saving of \$81,000 compared to the baseline, and a simple capital payback period of 6.5 years.

Figure 18: Total Energy Access scenario in Goudoubo, capital cost breakdown by customer type (\$)

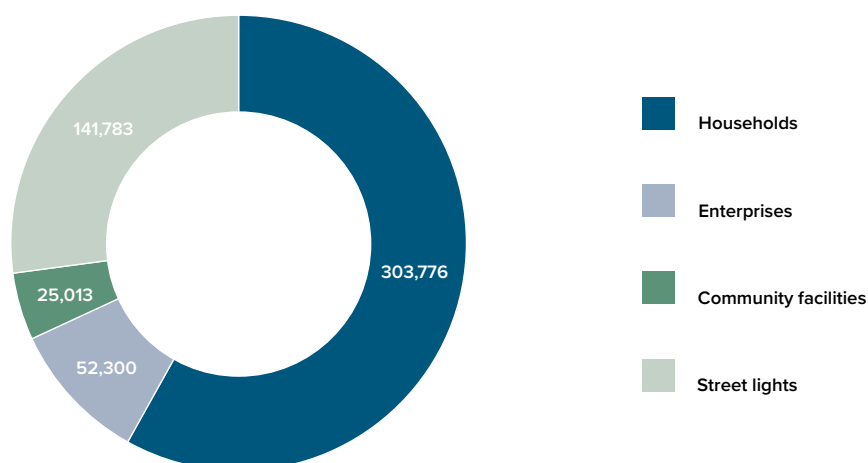


Table 14: 'Total Energy Access' scenario in Goudoubo, financial analysis

Capital cost (\$)	522,872
Operational cost (\$/year)	32,142
Capital cost per beneficiary (\$)	34
Baseline operational cost (\$/year)	112,821
Annual savings (\$/year)	80,679
Simple payback period (years)	6.5

To build a compelling case for investment in electricity infrastructure requires comprehensive data on baseline expenditure and quantification of the wide-ranging impacts. Productive activities and livelihoods enabled by electricity could potentially reduce refugee dependency on food rations and cash transfers, and enhance the business case for electricity infrastructure.

For families that require only lighting and charging, quality solar products represent the best value for money. The portability of products, which allows users to keep them when returning home, and their safety of operation in makeshift refugee shelters also make them a popular option.

Box 6: MEI project – market development for household energy products in Goudoubo

The refugees in Goudoubo have been the recipients of three separate handouts of solar lanterns in the past three years. There are concerns about the impact that free handouts might have on refugees' sense of 'ownership' of energy solutions. Despite this, product retention and usage appear high for the quality-verified goods, though the first set of products reportedly had a short working life with no availability of formal after-sales service. Suppliers in the host community have not been involved in the project, despite interested companies operating in the nearby town; instead, suppliers have been selected in the capital city, Ouagadougou, as these can marshal large product volumes and command lower prices. Refugees are still not able to buy quality-verified products at the local market. Clearly there is a need to transition to a model of self-sufficiency.

Table 15: Household energy product market development project design in Goudoubo

Market barrier	Proposed market development activity
Lack of awareness in the private sector of the commercial opportunity, combined with a perception of high risk.	Production of market intelligence describing the scale of opportunity and context. Organization of field trips for companies to the camp.
Weak private-sector capacity and lack of business models.	Business development. Development of cost-sharing pilot schemes. Distribution of case studies highlighting successful models.
Lack of quality-verified products on the market.	Promotion of quality-verified products, with support limited to companies working with these.
Lack of product quality, damaging consumer confidence. Low consumer awareness of quality-verified brands and consumer rights (such as warranties). Low willingness to pay for quality products (compared to cheap alternatives).	Provision of support to companies through marketing activities and brand building.
Limited availability of after-sales services.	Provision of support to local entrepreneurs in product repair.
Impaired development of commercial market as a result of aid agencies offering product handouts.	Creation of influence campaign to encourage alignment with market development strategy.

The MEI is implementing a project with the aim of establishing a market that can provide the camp population and host community with quality-verified household solar products and various cookstoves in perpetuity. This entails working with local companies to build their capacity and address supply chain barriers. The project has involved market analysis and a strategy exercise to identify the barriers to private-sector involvement, using a market systems development framework similar to that articulated in 'Building energy access markets. A value chain analysis of key energy market systems', a publication by EUEI PDF and Practical Action.⁸⁰ The main barriers and proposed solutions are presented in Table 15. Ten companies have been identified as potential partners in the project.

⁸⁰ EUEI PDF (2014), 'Building energy access markets. A value chain analysis of key energy market systems', <http://www.euei-pdf.org/en/seads/thematic-research-and-knowledge-sharing/building-energy-access-markets>.

Cooking in Kakuma I

Figure 19 shows the diversity of stove and fuels desired by the Kakuma I refugee population under the **'User preference' scenario**. An LPG stove is the top choice, preferred by more than one-third of families. Improved biomass stoves (basic or enhanced) are the top choice for one-third. Three-stone fires remain the preference for one-fifth of families, presenting a challenge for stove companies or distributors who have to work hard to stimulate demand despite the apparent health benefits and savings of their products.

The **'Willingness to pay' scenario** shows that the three-stone fire becomes the most common solution when cost is considered. Forty-four per cent of families are allocated the three-stone fire option because they are not willing to pay for their preferred stove. Only 55 per cent of families are willing to pay for at least a basic \$5 stove. This is lower than the 75 per cent currently using a basic stove, implying that the stove handouts to date have encouraged stove usage by 20 per cent of households in the camp. An alternative perspective is that the handouts have created a dependency syndrome and that people are no longer willing to pay for stoves.

One-quarter of families are willing to pay for a basic wood cookstove, and one-fifth for enhanced stoves. Only one-quarter of the families preferring the LPG option are willing to pay the levelized cost of \$2.10 per day (which combines the purchase price of the stove and cylinder and the recurring cost of refills). Still, this represents a significant number of families (some 1,400 households) and represents an opportunity for promoters of clean cooking.

Figure 20 shows that realizing the **'User preference' scenario** in Kakuma I would cost \$16,500 per day, or \$6 million per year. This is more than double the cost of the baseline scenario, implying that significant additional investment by donor agencies would be required to achieve this scenario. Seventy-two per cent of the 'User preference' scenario's cost originates from the 37 per cent of families that desire LPG.

The **'Willingness to pay' scenario** has a cost of \$11,000 per day associated with it. The expressed willingness of camp residents to pay for cookstoves and fuels implies a total cost of \$5,500 per day, nearly \$2,000 per day more than under the baseline. Half the cost of the scenario originates from people using a three-stone fire. The model sets the three-stone fire as the default option for families not willing to buy a stove, even though the daily cost of fuel is high.

To achieve a universal **'Clean cooking' scenario** that meets global health standards with ethanol would cost a staggering \$24,000 per day, or nearly \$9 million per year. Achieving full clean cooking with a mix of LPG (93 per cent) and biogas (7 per cent) would cost \$31,000 per day. Smart subsidies or fiscal incentives could dramatically reduce costs and make these solutions more attractive, but sustainable biomass and alternative fuels are likely to continue to be part of the solution in Kakuma I.

Targeting 100 per cent basic ICS usage would cost \$4,500 per day or \$1.6 million per year, whereas 100 per cent enhanced ICS usage would cost \$5,500 per day (and require significantly more upfront capital). Both scenarios offer savings in relation to the full economic cost of the baseline.

Figure 19: Cooking energy scenarios – stove and fuel preferences, Kakuma I

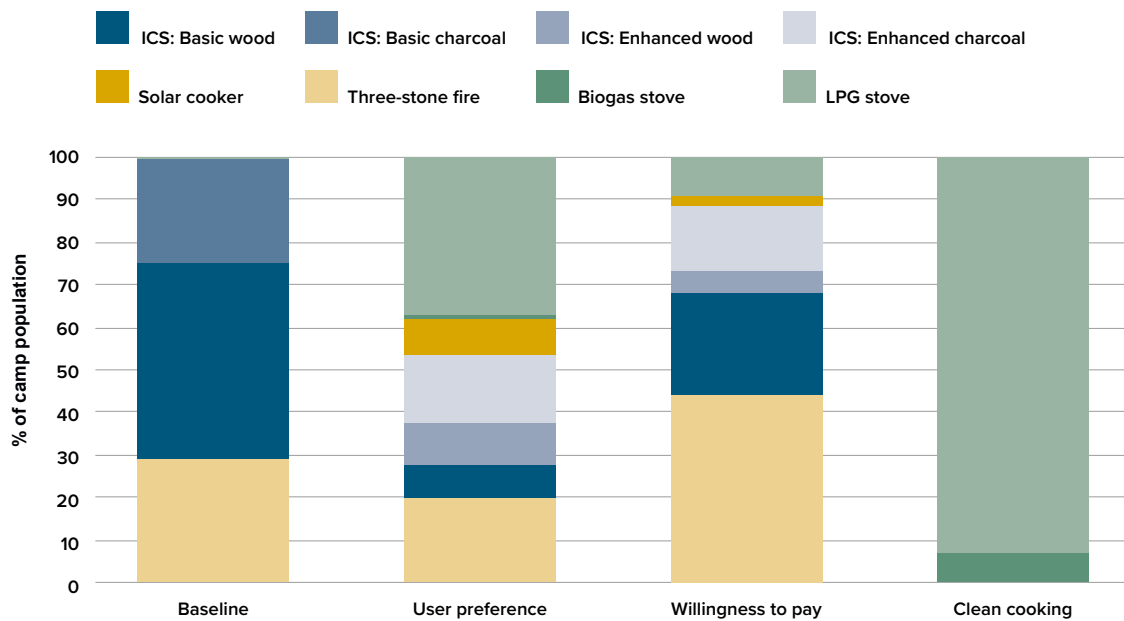
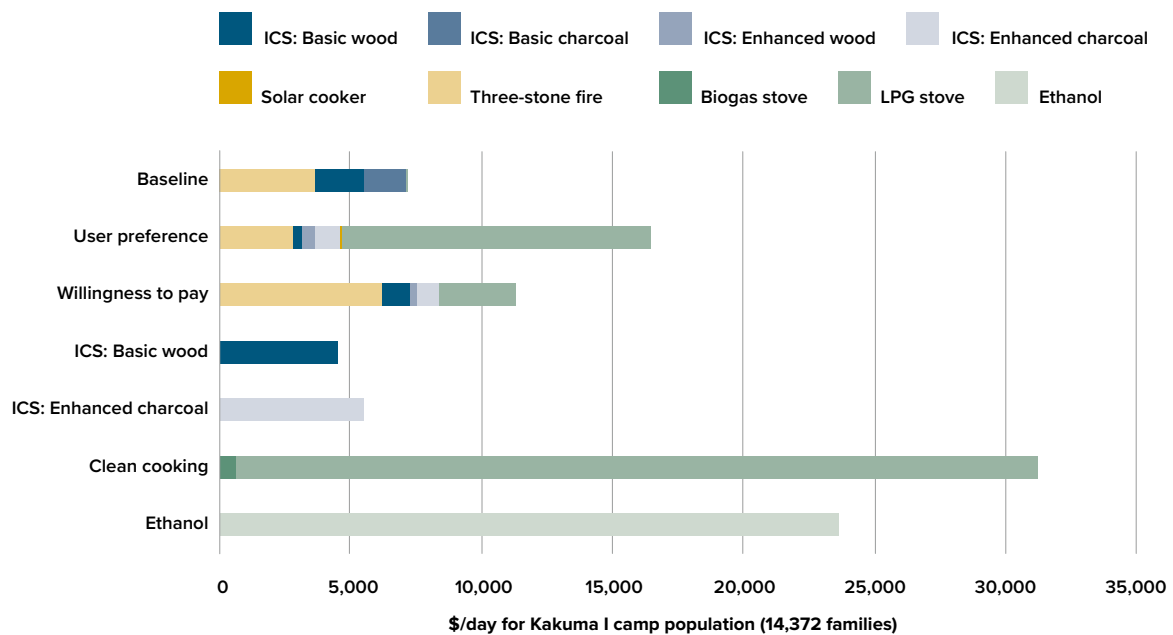


Figure 20: Daily levelized costs of cooking energy scenarios in Kakuma I



Note: Ethanol is not included in the 'Clean cooking' scenario since it is not commonly available on the market.

Light and power in Kakuma I

Figure 21 displays the access to technology for the Kakuma I light and power scenarios. Household solar products and mini-grids are favoured, since the national grid is a long distance from the camp. Costs of capital and operation are calculated for diesel generators, renewable power sources and hybrid solutions.

The **'User preference' scenario** shows that 100 per cent of the population would like access to grid electricity and a range of electrical appliances. A stated demand exists for power for households, enterprises, community facilities and street lights.

Table 16 shows the desired access to electrical appliances. All respondents indicated a desire for at least a few lights, a phone charger and entertainment (i.e. Tier 2); 77 per cent wanted additional appliances and the ability to use them throughout the day. Respondents were assigned an electricity access tier based on the appliances they would like and the amount of usage they wished to have.⁸¹

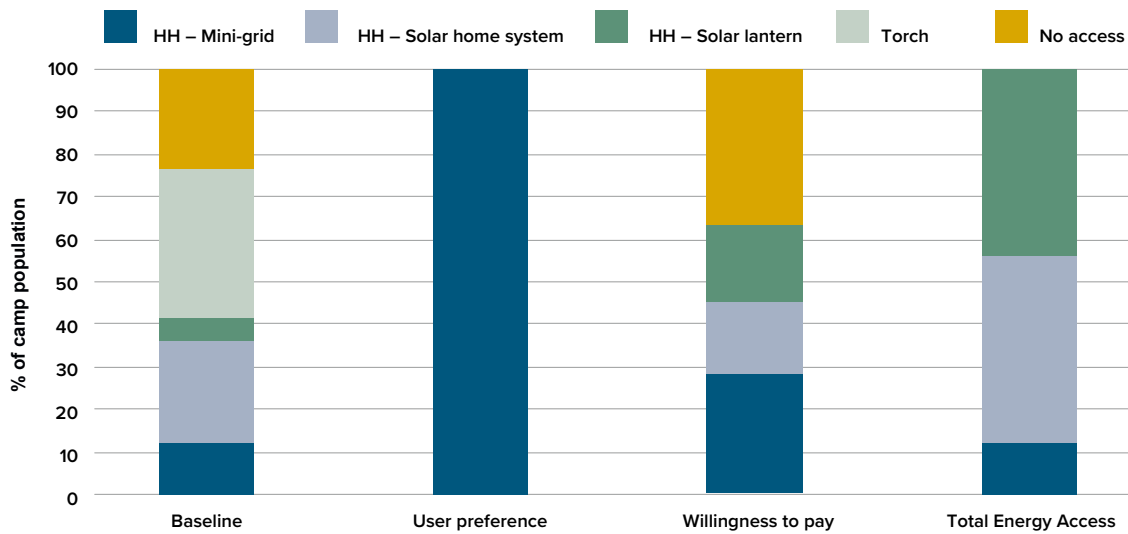
Table 16: Electricity access tier desired by refugees, Kakuma I

SE4All tier	Indicative appliances available at tier	% of households
0	Single light or no device	0
1	Minimal light, charger	0
2	Multiple lights, charger, efficient television, radio or fan	23
3	Tier 2 + electric fan, fridge, etc.	57
4	Tier 3 + more appliances and usage	11
5	Unlimited use	9

The 'User preference' scenario also incorporates the supply of mini-grid electricity to 75 per cent of enterprises and 85 per cent of community facilities (the remainder of these two cohorts indicated that they did not need an electricity supply). Assuming the provision of power from a diesel generator, this scenario has a capital cost of \$8.9 million and an annual running cost of \$2.8 million. Its LCOE is \$4.3 million per year, but respondents are only willing to pay \$2.8 million per year for this level of service – implying that a subsidy of \$1.5 million per year would be required. The scenario calculates a maximum demand of 6 MW and annual consumption of 12,000 MWh per year. Solar-diesel hybrid systems typically have a lower LCOE than purely diesel-powered systems, but they require greater upfront finance.

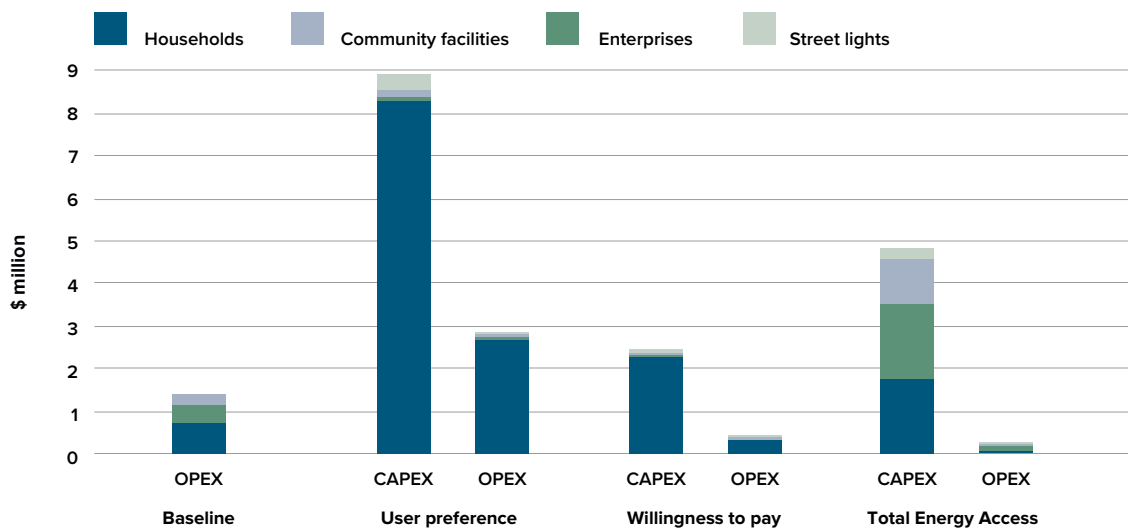
⁸¹ Ability to pay for appliances was not explored.

Figure 21: Lighting and power scenarios for Kakuma I – refugee households' access to different supply technologies



Note: The levels of access for enterprises and community facilities are not indicated on this chart.

Figure 22: Light and power scenarios in Kakuma I – capital expenditure (CAPEX) and operating expenditure (OPEX)



Note: CAPEX for baseline unknown. The operating cost for the 38 per cent not allocated a device in the 'Willingness to pay' scenario is not included.

In the **'Willingness to pay' scenario**, 28 per cent of households indicated their readiness to bear the full costs of a mini-grid. Diesel generation and distribution to serve only these people would have a capital cost of \$2.4 million and a levelized cost of \$0.8 million per year. Seventeen per cent of households would pay for a \$126 solar home system (with multiple lights and charger), and 18 per cent for a \$10 solar lantern (a small task light).⁸² This indicates a solar-product market of 5,000 households, worth \$300,000. Some 5,400 families (38 per cent of the total in Kakuma I) said they were not willing to pay for any of the proposed options.

The **'Total Energy Access' scenario** is not defined by refugee input but by the principle that every household, business and community facility should have access to modern energy. It allocates a Tier 2 mini-grid connection to 12 per cent of households, a \$100 solar lantern set (multiple lights and charger) to 44 per cent of households, and a \$20 solar lantern (single light and charger) to 44 per cent of households.⁸³ In this scenario the clinics, schools and operations buildings all have mini-grid electricity, as do the street lights and water pumps. Fifty per cent of enterprises have a grid connection on which to run high-power appliances, and 50 per cent have a solar lantern set.

This scenario assumes a solar-diesel hybrid system with storage. The system has a capital cost of \$4.8 million and an annual running cost of \$0.2 million. The peak demand is 466 kW and annual consumption is 1,298 MWh per year. Enterprises and community facilities are assumed to dominate energy demand, and therefore account for the largest share of the cost.

Table 17: Light and power scenarios in Kakuma I, financial analysis

	Willingness to pay	Total Energy Access
Capital cost (\$m)	2.43	4.80
Operational cost (\$m/year)*	0.34	0.21
Capital cost per beneficiary (\$)	54	67
Baseline electricity costs (\$m/year)	1.37	1.37
Annual savings (\$m/year)	1.03	1.16
Simple payback period (years)	2.4	4.1

*The 'Willingness to pay' operational cost does not include the operating costs of the traditional solutions used by the 38 per cent of the population not assigned a service.

Figure 22 compares the economics of the different scenarios, using analysis of capital and operating costs. The 'User preference' scenario entails a capital cost of nearly \$9 million to provide 14,000 households with a mini-grid electricity supply. The strikingly high costs would require major investment from donors, and exceed the amount refugees are willing to pay. While the social and livelihood benefits would be significant, it is difficult to imagine this level of service being a priority for donors.

⁸² Respondents were asked about their willingness to pay the LCOE (i.e. a daily amount), not the full capital cost in a single purchase. This simulates a fee-for-service/pay-as-you-go model.

⁸³ Mini-grid access is allocated to the 12 per cent of households that currently have access to a diesel micro-grid; as such, the solar-diesel mini-grid system represents a substitute for the many smaller standalone diesel generators. The remaining 88 per cent of households are allocated large or small solar products according to income.

The 'Willingness to pay' scenario indicates the apparent financial viability of a mini-grid to serve 28 per cent of households in Kakuma I, combined with provision of household solar systems or solar lanterns for 35 per cent of families. Table 17 shows a capital cost of \$2.43 million and a break-even period of 2.4 years, with savings of \$1 million a year on operating costs compared to the baseline scenario. The high price of diesel and inefficiency of many small generators make the current situation a less cost-effective way of supplying electricity to the camp.

The 'Total Energy Access' scenario entails a capital cost of nearly \$5 million but relatively low annual operating costs of \$0.21 million, enabling a break-even point in 4.1 years. The scenario relies on enterprises and camp facilities as anchor customers for the mini-grid and extends coverage to poorer households through cheaper solar products.

Box 7: MEI report – powering camp facilities in Kalobeyei

Kalobeyei camp is a new settlement planned to accommodate the increasing number of refugees in the Kakuma complex. It provides an opportunity to pilot a different and better approach to assistance programming. The MEI has produced an infrastructure management report assessing options for electricity supply to the major camp facilities (10 buildings including health clinic, school, police station, market and vocational centre) in the first of three clusters. Figure 23 shows the capital costs, operating costs and financial analysis of the following options:⁸⁴

- **Multiple standalone diesel generators** for each of the major buildings (the typical power provision system). Aggregated capacity of 164.5 kVA.
- **Mini-grid with diesel generation.** Capacity of 210 kVA with distribution network to all the camp's major buildings.
- **Mini-grid with diesel generation, solar PV and battery storage.** Capacity to meet demand of 350 kWh/day, with 75 kWp solar PV and 12v, 8,000 A-h (Ampere hour) battery bank. This would allow power provision to the camp's major buildings along with an excess for other users.

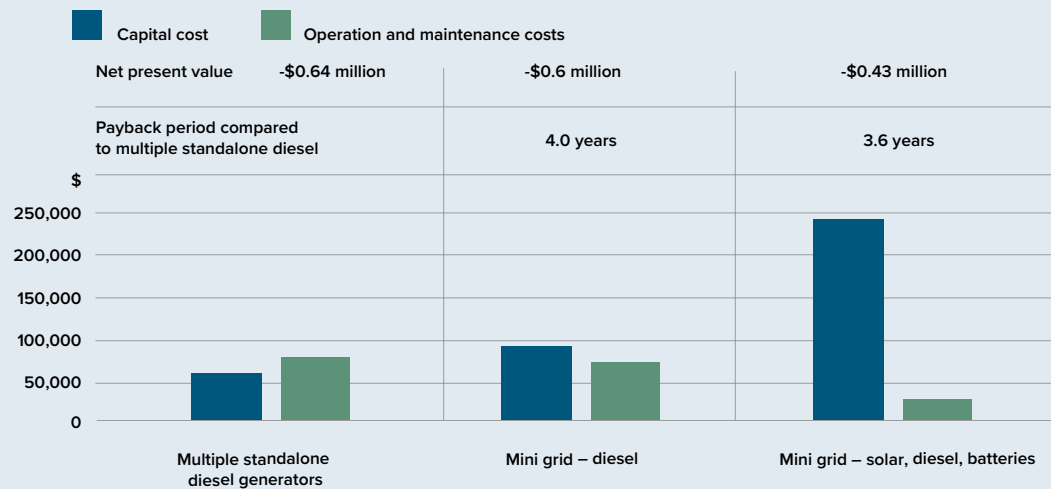
The financial analysis shows that mini-grids are more economical to run than multiple standalone generators, indicating that the status quo electricity supply in the majority of refugee camps is inefficient and expensive. Furthermore, **solar-diesel hybrid solutions are more economical than diesel alone, though they require high upfront investment and robust risk management.**

⁸⁴ Capital costs are preliminary estimates subject to further validation in conjunction with suppliers. The capital costs are discounted over a 15-year product life. The PV array and diesel generators are assumed to have operational lifespans longer than this period. The batteries are assumed to be replaced in Years 5 and 10. The costs for the mini-grid systems include a 5-kilometre distribution system.

Operation and maintenance costs: diesel is assumed to cost \$1 per litre. For the standalone generators option, operation is assumed to be provided by employing three operatives. For the other options, a labour force of two operatives is assumed. The plant suppliers will require ongoing maintenance to enforce warranties. The cost of this maintenance is assumed to be covered by the labour cost.

Financial appraisal is done using a discounted cashflow model; the table shows the net present value of each option, with a discount rate of 10 per cent used. Today's prices are used; no provision has been made to adjust for the possible disproportional inflation of energy costs. No adjustment has been made for possible tax or grant impacts. The payback period is calculated by dividing the additional capital cost of the mini-grids by the reduction in operating and maintenance costs.

Figure 23: Comparing electricity supply options for Kalobeyei



The report recommends a mini-grid with solar-diesel hybrid generation and battery storage. The initial capital investment is estimated at \$243,000 with an operating cost of \$25,400 per annum. While this solution is initially more expensive than multiple standalone diesel generators (which require an estimated upfront investment of \$62,200), annual savings on operating costs are estimated at \$49,800, meaning that the additional investment would be repaid within 3.6 years. This option also offers a more reliable supply for users and reduced greenhouse gas emissions.

The report endorses private-sector involvement in the provision and management of the mini-grid as a way of ensuring professional operation of the system and hence the sustainability of infrastructure. The private sector could finance the capital provision of the project if the revenue streams were guaranteed. Initial contact with the private sector indicates that there would be interest in the project. The MEI will now invite proposals from private-sector providers.

The fragmented organization of the humanitarian system is a significant barrier to the implementation of centralized mini-grids supplying electricity to users in numerous clusters. An overview of each user is needed to complete the assessment, design, financing and implementation of such a system – requiring greater coordination among clusters or the establishment of a distinct energy cluster/lead.

6. Conclusions

The energy access situation

A **low level of energy access in both camps exacerbates poverty** and hampers relief and development efforts. Ninety-nine per cent of households in Goudoubo and 86 per cent in Kakuma I have a Tier 0 or Tier 1 ranking for cooking and lighting access. This signifies a severe deficit in terms of energy access, and a failure to meet standards commensurate with a healthy and productive life.

Given the current inadequate level of energy provision in the camps, there is demand among refugees and humanitarian organizations for change.

Given the current inadequate level of energy provision in the camps, there is demand among refugees and humanitarian organizations for change. One-quarter of families in Kakuma I and one-third of families in Goudoubo still cook on three-stone fires, and obtaining sufficient fuel for cooking is expensive and sometimes dangerous. Entry-level solar products are common, but meet only the most basic lighting and charging needs.

Without a grid connection or a centrally organized mini-grid system in the camps, implementing agencies are spending more money than necessary to power priority facilities such as health clinics, using arrays of standalone diesel generators. Each camp has an active Energy and Environment Working Group with a resource allocation from donors. However, as with other sectors, their budgets are underfunded.

Energy scenario insights

A significant proportion of refugees are willing to pay for clean and efficient energy technologies.

In Goudoubo, two-thirds of residents – some 2,000 families – indicated a willingness to pay for cooking solutions up an aggregate value of \$270,000 per year. In Kakuma I, more than one-third of residents expressed a willingness to pay for quality household solar products, indicating a customer base of 5,000 families and a market worth some \$300,000.

There is demand and need for a diversity of energy technologies that give varying levels and qualities of service, as no 'one size fits all'. Stove promoters need to recognize this diversity to achieve universal access. Likewise, a combination of a centralized electricity supply system for camp facilities and refugee enterprises, and solar products for households, is required.

Clean cookstoves and fuels are in high demand, but require much greater investment to be introduced at scale. The majority of families would like to cook on stoves that use less fuel and produce less smoke. Clean cooking appears attractive if the full economic benefits (financial, health and environmental) are calculated, but to achieve this would require two to four times the current level of investment.

Solid biomass and improved cookstoves will continue to be important cooking options in Kakuma I and Goudoubo, as well as in other refugee camps. A shift to more efficient cooking can be achieved at little or no extra cost for the significant proportion of people who still cook on three-stone fires. Universal adoption of improved cookstoves would reduce fuel consumption and expenditure.

Quality-verified household solar products meet the basic needs of families and are low-cost. Users of such products spend dramatically less money on light and power than do people using inferior technologies; household solar products therefore represent good value for money for refugees and donors. Strong brand recognition and a high willingness to pay point to a large market and a significant opportunity for the private sector.

Centralized electricity supply solutions – in the form of mini-grids or grid connections – are more economical than multiple standalone diesel generators. Grid connection or mini-grid supply is a good option for camp facilities and enterprises with large demand and high expenditure on diesel generators. The current piecemeal and ad hoc practice whereby each facility manages its own supply is inherently wasteful. Greater coordination among humanitarian clusters is required to assess, design, finance and implement such systems. Extending service to higher-income households may also be viable, although providing universal coverage via centralized solutions is likely to be prohibitively expensive. **Solar-diesel hybrid solutions are more economical than purely diesel systems**, but they require a high upfront investment and robust risk management.

Purely solar-powered water-pump schemes are viable in most camps for displaced people, offering a quick return on investment (typically one to three years) and large cost-saving opportunities. A robust context analysis that assesses security and identifies a local operation and maintenance model is necessary alongside capacity-building of WASH teams.

In cases where the refugee camp and host community are close to each other – such as at the Kakuma complex – opportunity exists for a cost-efficient and equitable mini-grid that supplies both constituencies.

In cases where the refugee camp and host community are close to each other – such as at the Kakuma complex – opportunity exists for a cost-efficient and equitable mini-grid that supplies both constituencies. UNHCR could provide the impetus for such investment through power-purchase agreements or guarantees.

The opportunity for private-sector engagement

Currently, energy interventions in refugee camps are largely developed and executed by humanitarian actors, even though many of these organizations have limited expertise in the development and management of cost-efficient and effective energy solutions. Given the private sector's experience in providing market-tested energy products and services to low-income customers in developing countries, the use of private-sector suppliers could add significant value in humanitarian settings.⁸⁵

⁸⁵ Van Landeghem (2016), *Private-Sector Engagement: The Key to Efficient, Effective Energy Access for Refugees*.

Companies agree that they could play a critical role in this space. They note that **significant cost and operational efficiencies could be achieved in camps by shifting to alternative technologies** and optimizing energy access supply chains. **Private-sector capital financing is also a possibility** if revenues can be guaranteed through power-purchase agreements and robust risk management.

Humanitarian actors have recognized the need for policy to shift from free handouts to engaging with local markets for provision of products and services for post-emergency response. There are, however, notable challenges to private-sector delivery of energy access in refugee camps – challenges that require technical, project and business innovation. However, engagement with the private sector requires a transformation in mindset and approach if greater impact and sustainability are to be achieved in energy interventions.

Agenda for change

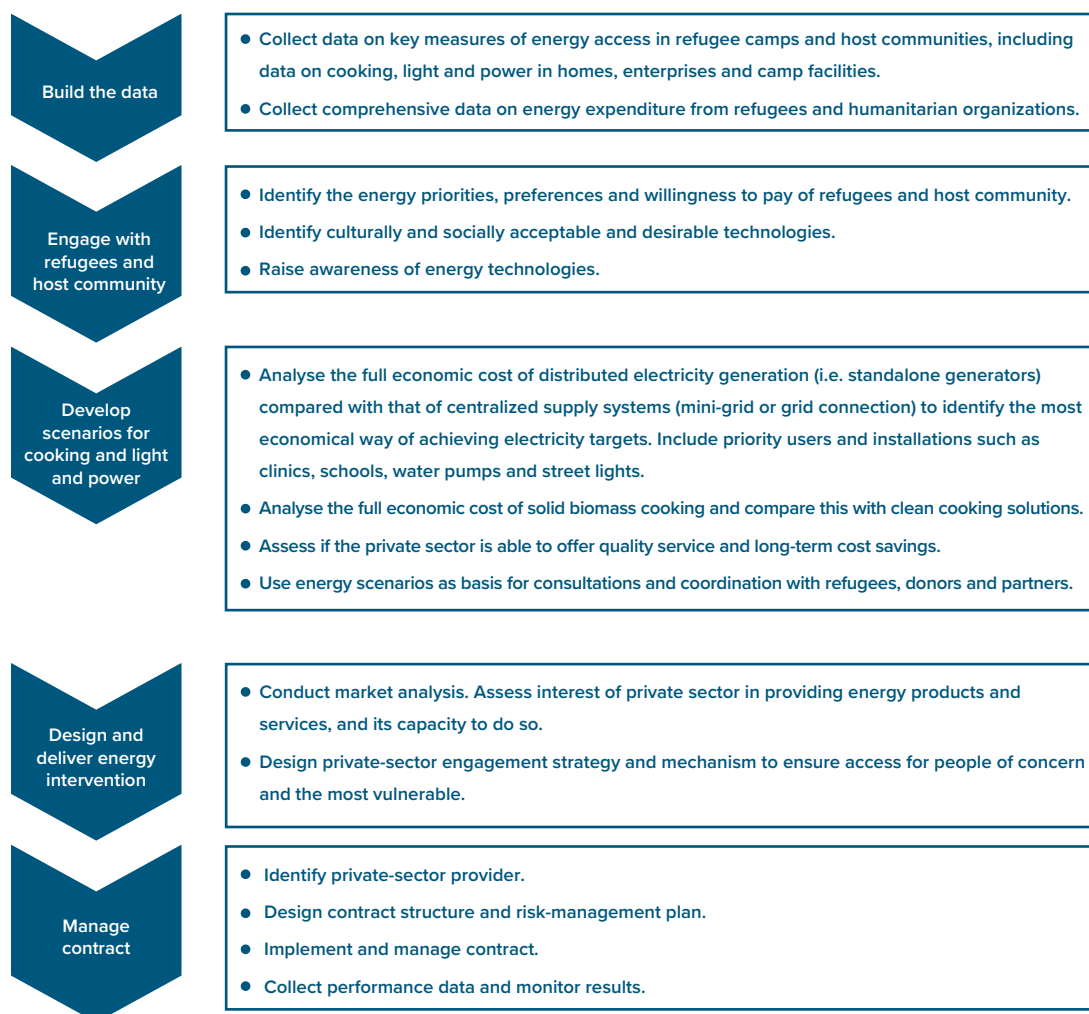
A concerted effort to **build the data** on how people cook, and on how they light and power their lives, is necessary to design appropriate and impactful solutions. Collecting comprehensive data on energy expenditure by families and camp facilities will also enable identification of potential cost savings. **UNHCR and implementing partners should adopt a common framework for defining and measuring energy access** in refugee camps (Annex 2 suggests a list of key indicators). This should form the basis for minimum standards and targets of energy access.

Engagement with refugees and host communities is critical to gaining an understanding of their priorities, preferences and willingness to pay for different energy solutions. Handing out products that do not satisfy their needs or are not culturally acceptable impairs the sustainability and impact of initiatives, and compels refugees to find other means of meeting their needs at greater cost.

Mini-grids and renewable technologies should be included in light and power scenarios at the camp level, so that potential cost savings and improvements in operational efficiency can be identified. **Cooking scenarios should analyse the true cost of cooking** by using approaches such as levelized cost of energy figures or cost–benefit analysis. Energy scenarios should be used to create a platform to develop a shared vision among refugees and implementing agencies.

Implementing agencies should explore approaches to engagement with the private sector in order to leverage the latter's technical expertise, promote financial innovation, generate cost savings, and create wider benefits for host communities.

Figure 24: An agenda for improving refugees' energy access

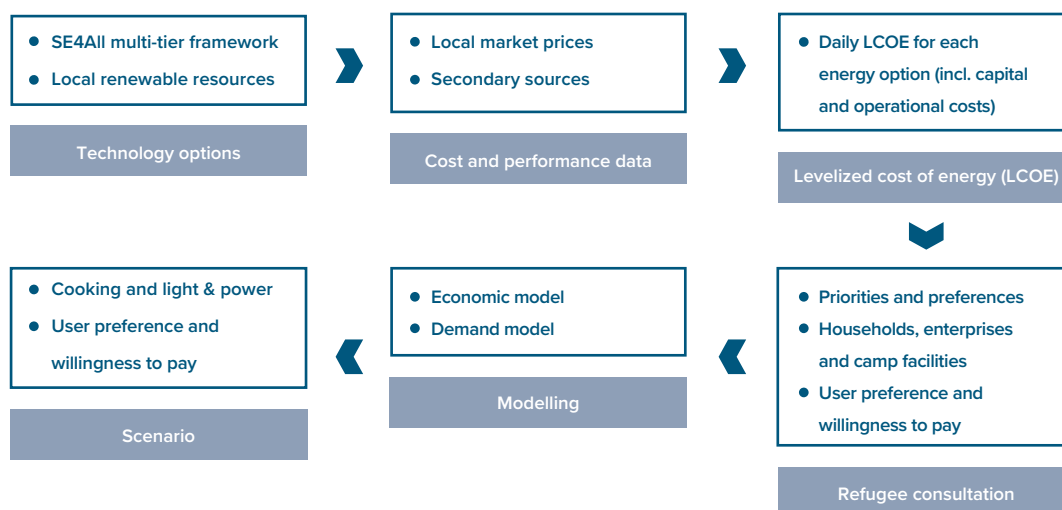


Annex 1: MEI Energy Access Scenario Methodology

Overall purpose

The Moving Energy Initiative (MEI) has engaged with refugees in Goudoubo and Kakuma I to produce energy scenarios for the camps. The scenario development process is outlined in Figure 25.

Figure 25: Scenario development process



The approach aims to provide insights for camp planning based on holistic needs and according to the real circumstances and perspectives of the refugees. The camp scenarios therefore encompass:

- All spheres of energy access (households, productive uses and community facilities), while noting the different needs of men and women;
- All forms of energy access (electricity, cooking, heating and mechanical power); and
- All feasible and appropriate means of energy provision (grid-connected, mini-grid and standalone).

The methodology is grounded in meaningful interaction with refugees. Realistic information was shared about energy access options, and community members' priorities and preferences were sought and recorded. Refugees' responses were subsequently translated into scenarios that provide valuable information on:

- Technologies and approaches most likely to deliver improved energy access;
- Aggregate costs of achieving holistic solutions (instead of piecemeal delivery of different elements); and
- Levels of access likely to be achieved if delivery is based solely on individuals' willingness to pay (this confirmed the need for meaningful public support).

The creation of the scenarios draws on a method developed by Practical Action for participatory community energy planning. This was developed with communities in Kenya, Togo and Bangladesh, whose energy plans are documented in *Poor people's energy outlook 2016*.⁸⁶ The approach was further refined by the MEI.

The two camps provide valuable insights that can inform energy access planning and priorities in other localities.

Goudoubo and Kakuma I camps were selected for scenario mapping as they are the focus of the MEI. The plans developed are specific to the two camps, which do not form a statistically representative sample or encompass the full range of refugee camp types. However, the two camps provide valuable insights that can inform energy access planning and priorities in other localities. The exercise would add value in any refugee camp as part of a process to improve energy access. Engagement with refugees to better understand their priorities, preferences and willingness to pay for different energy solutions is invaluable for ensuring the impact and sustainability of interventions.

Data collection

Researchers visited both camps to explain the exercise, what it would achieve and its limitations (particularly given that the MEI could not commit to implementing the output scenario). No energy literacy campaign was conducted that might have shifted preferences for particular energy services or technologies. Each camp was mapped with recorded numbers and locations of households, productive activities, facilities and energy resources.

This enabled the identification of viable electricity supply options for each camp and for the establishment of potential grid distribution coverage areas. Typical electrical usage profiles were developed for households, enterprises and community facilities for different tiers of energy access, based on the SE4All multi-tier index (Table 18).

⁸⁶ Practical Action (2016), *Poor people's energy outlook 2016*, <https://policy.practicalaction.org/policy-themes/energy/poor-peoples-energy-outlook>.

Table 18: SE4All multi-tier index for household access to electricity

		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
1. Capacity	Power*		Very low power min. 3 W	Low power min. 50 W	Medium power min. 200 W	High power min. 800 W	Very high power min. 2 kW
	AND daily capacity		Min. 12 Wh	Min. 200 Wh	Min 1.0 kWh	Min. 3.4 kWh	Min. 8.2 kWh
	OR services		Lighting of 1,000 lmhrs per day and phone charging	Electrical lighting, air circulation, television and phone charging are possible			
2. Duration	Hours/day		Min. 4 hrs	Min. 4 hrs	Min. 8 hrs	Min. 16 hrs	Min. 23 hrs
	Hours/evening		Min. 1 hr	Min. 2 hrs	Min. 3 hrs	Min. 4 hrs	Min. 4 hrs
3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total durations <2 hrs
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability					Cost of a standard consumption package of 365 kWh per annum is less than 5% of household income		
6. Legality						Bill is paid to the utility, prepaid card seller or authorized representative	
7. Health and safety						Absence of past accidents and of perception of high risk in the future	

*The minimum power capacity ratings in watts are indicative, particularly for Tier 1 and Tier 2, as the efficiency of end-user appliances is critical to determining the real level of capacity and thus the type of electricity services that can be performed. Source: Practical Action (2016), *Poor people's energy outlook 2016*.

Cost and performance data were collected on energy technologies and fuels, either locally or using information published by product suppliers. HOMER (hybrid optimization of multiple energy resources) software was used to obtain the generation costs for mini-grids. For cooking, the stove selection considered a range of qualities (SE4All Tiers 1–4) and clean-fuel options including solar cooking, biogas, LPG, bioethanol and electricity. The daily costs of providing each access option at different tiers in each camp were estimated using these data and a bespoke economic model. The data represented end-user costs of provision and did not account for externalities in several categories: environmental (carbon emissions, deforestation, land-use change), social (unpaid domestic work) or political (subsidies). The costs therefore remain approximate but are reasonably representative.

Table 19: Fuel use, fuel price and stove costs for cooking options in scenarios

	Fuel use (kg/day/HH)	Stove cost (\$)	
Three-stone fire	18.4	–	
ICS: Basic wood	5.7	5	
ICS: Basic charcoal	2.1	5	
ICS: Enhanced wood	4.4	125	
ICS: Enhanced charcoal	1.6	48	
LPG	0.8	66	
Solar cooker	–	137	
	Fuel price (\$/kg)		
	Wood	Charcoal	LPG
Goudoubo	0.05	0.17	0.77
Kakuma I	0.05	0.20	2.46
	Fuel price (\$/MJ)		
	Wood	Charcoal	LPG
Goudoubo	0.0042	0.0057	0.18
Kakuma I	0.0042	0.0070	0.56

Note: The fuel price was obtained from a market in the camp. Data on fuel use per day reflect typical values from secondary research.

Based on the results of this analysis, refugee communities were consulted to determine their energy needs, priorities and willingness to pay for electricity, cooking and street lighting. This consultation involved surveying a sample of households, enterprises and camp facilities. It also included participatory activities with a focus group of refugees in each location. In the household surveys we asked about:

- Household demographics, employment and income;
- Current energy access and expenditure;
- Priorities for the community (between energy for households, productive uses and community facilities) and for the respondent household (between different forms of access); and
- Preferences and willingness to pay⁸⁷ for different solutions.

For each energy option, an information card was shown to the respondent, briefly describing its costs and key attributes (see Table 20). The costs presented were based on the means of providing the type and level of access that achieved the lowest daily cost for users. The cost was expressed as a daily amount to provide a single comparator between options with different capital and operational cost profiles. This effectively assumes that a user will be able to access a particular solution on a pay-for-service basis.

For enterprises and community facilities, we asked about:

- The enterprise or community facility itself;
- Current use of, and need for, various energy applications (lighting, ICT/entertainment, motive power, heating and cooling);
- Current energy access and expenditure; and
- What appliances/items of equipment people needed to power, and how much they would be willing to pay for energy for these.

Focus group discussions were held in each community using a range of participatory methodologies to get a more nuanced view of needs and priorities. As with the surveys, discussions focused on:

- The energy access situation and how the need for and availability of energy vary throughout the day, throughout the year, and geographically within the community;
- Each camp's needs for various energy services (such as household lighting, cooking, agro-processing and education), and the relative importance of these needs; and
- Views and preferences regarding possible means of energy provision (such as lanterns, home systems or system connections).

⁸⁷ The cards used to elicit willingness to pay had no reference to prices to avoid anchoring or biasing the response. Respondents were then asked for the highest price they would be willing to pay per day. If the answer was 'I don't know', a price was suggested (based on the LCOE for that technology) and the respondent was asked whether they would purchase. This question was repeated with two or three different prices to obtain a range of responses.

Table 20: Attributes of cooking solutions presented to survey and focus group participants

Stove type	Smoke/cleanliness	Fuel requirements	Cooking
Basic improved stove using wood, straw or dung	Cleaner and less smoky	Uses a third less fuel than a traditional stove	Saves 30 mins cooking time/day
Enhanced wood fuel stove	Pollution greatly reduced, so kitchen and pots much cleaner	Uses two-thirds less fuel, but fuel needs to be cut into 5 cm pieces	Saves 45 mins cooking time/day
Enhanced charcoal stove	Pollution almost zero	Uses two-thirds less fuel	Saves 45 mins cooking time/day
LPG stove	Good for health: no smoke, very low pollution	Need to swap heavy cylinders (25 kg), and cylinder can run out during cooking	Lights instantly, good control of flame and heat
Solar cooker	Completely clean	No fuel required, but can only be used during the daytime and needs to be realigned every hour or so	Heat can fry foods, but cooks slowly
Electric cooker	Completely clean	Only possible with a high-quality electricity connection	Good control over heat

Analysis and scenario mapping

Having mapped energy sources, technologies and levels of access, we then modelled three scenarios for the mix of energy access to best meet each camp's needs and priorities:

1. **'User preference'**: respondents' views of their needs based on the electrical applications and appliances they wished to use, and on the cooking solution they ranked most highly.
2. **'Willingness to pay'**: the level and forms of access for which people were willing to pay the full cost.
3. **'Total Energy Access'**: not defined by refugee input but by the principle that every household, business and community facility should have access to modern energy.

Information from the focus groups was used to triangulate the plans and, in particular, to help identify productive uses of energy, beyond those put forward by existing enterprises, that would enable economic growth. For each scenario, we identified the best means of providing the energy needed, based on a combination of costs and preferences. For distribution systems,

average and maximum daily electrical demands were calculated and aggregated across the community, costs were recalculated, and the selection process was re-run using these costs. This iterative process was repeated until the combination of electricity access provision (mix of system connection and standalone technologies) and its total cost could be established.

The modelling aimed to produce the lowest cost for the camp as a whole for the refugee-defined inputs. Thus, for example, a larger distribution system might be chosen if it reduced the number of relatively expensive standalone systems, even if that meant increasing the cost for those connected to the system. Finally, we compared the costs of powering loads such as pumps and mills using electricity and mechanical power; if mechanical power could be provided at lower cost, the loads were removed from the electrical demand and the planning process repeated. The process for modelling the cooking scenarios was similar, but based on individual rather than community choices.

MEI energy access scenario resources

In the process of undertaking the energy access scenario modelling, the project produced a series of tools, including:

- Questionnaires for households, enterprises and community services
- Key informant interview and focus group discussion guidance
- Energy product/service information cards
- An energy solution tool
- A cost and performance data tool

A set of reports was also produced for Goudoubo and Kakuma I camps, covering:

- The current situation
- Needs and priorities
- A cooking plan
- An electricity plan
- A Total Energy Access plan

The tools and reports are available from the MEI upon request.

Annex 2: Key Indicators for Measuring Energy Access in Refugee Households

Cooking	Type of primary cookstove and associated fuel/s
	Type of secondary cookstove and associated fuel/s
	Amount of fuel used per person per day
	Average household expenditure on all fuels for cooking per month
	Amount of fuel ration received per person per month
	Market price of all available stoves
	Market price of wood, charcoal, LPG and other cooking fuels
	Amount of time spent cooking (disaggregated for women, men and children in household)
	Amount of time spent per week collecting wood (disaggregated for women, men and children in household)
	Amount of time spent cooking (disaggregated for women and men)
	Occurrence of health problems and burns from cooking
	Lighting
Number of lights from primary light source	
Hours of light per night from the primary light source	
Ownership and usage of solar light received from UNHCR	
Amount spent on light source in the last month	
Availability of quality-verified household solar products on the market	
Feeling of safety inside the home	
Feeling of safety outside the home	
Occurrence of health problems and burns from lighting	
Mobile phones	Number of mobile phones owned by the family
	Ability to charge mobile phones at home
	Amount spent on charging mobile phones in the last month

About the Authors

Drew Corbyn is an independent consultant with 10 years' experience promoting off-grid light and power technologies in developing countries. His foremost experience is in development consultancy and project management with a focus on catalysing markets and private-sector development. As a development consultant he has provided assistance to the private sector, governments, donor agencies and NGOs. He helped establish Malawi's first independent power provider – a micro-hydro mini-grid social enterprise – and supported six off-grid lighting companies in the country. He has authored numerous publications and articles on topics including market analysis and strategy development, policy studies and advocacy, and technology and social impact. He holds a master's degree in mechanical engineering from the University of Nottingham and has lived and worked in Asia, Africa, Latin America and Europe.

Mattia Vianello is the Africa/Global Energy Advisor with Practical Action. His research interest is in energy market systems in development and humanitarian contexts. Mattia is an experienced consultant, and during the past eight years has managed and delivered research and technical assistance to donors, the private sector and NGOs in West Africa, East Africa, Asia and Central America. Mattia is Practical Action's project manager for the Moving Energy Initiative, for which he is leading research activities in refugee camps and managing a market development programme in Burkina Faso. In addition, in Kenya he is currently supporting mini-grid companies under the Green Mini-Grid facility and providing technical assistance to two national cookstove programmes. Prior to joining Practical Action, Mattia worked in Haiti as coordinator for an environmental programme in camps for internally displaced people and worked for an international NGO promoting ethanol cookstoves in refugee camps in Ethiopia. He holds an MSc in science and technology policy and management from the University of Edinburgh, and a BA in philosophy from Vita Salute San Raffaele University in Milan.

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Cover image: Father and daughter in their shelter in Goudoubo refugee camp, Burkina Faso, March 2017.

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