SUNNY

DELIVERABLE 1.1

Analysis of local contexts

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Nature of the Deliverable		
R	Document, report	X
DEM	Demonstrator, pilot, prototype	
DATA	Data sets, microdata, etc.	
OTHER	Software, technical diagram, etc.	

Dissemination Level		
PU	Public, fully open and automatically posted online	X
SEN	Sensitive, limited under the conditions of the Grand Agreement	
CI	Classified information: RESTREINT UE (Commission Decision 2015/444/EC)	
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Nature of the Deliverable			
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LIST OF ACRONYMS

Term	Acronym
AD	Anaerobic Digestion
CBA	Cash-Based Assistance
CRRF	Comprehensive Refugee Response Framework
DEPs	District Energy Plans
DGIE	Directorate General of Immigration and Emigration
DRC	Democratic Republic of the Congo
EACREEE	East African Centre for Renewable Energy and Energy Efficiency
EAQIP	Energy Access and Quality Improvement Project
EASP	Electricity Access Scale-Up Project
EPR	Extended Producer Responsibility
ERA	Electricity Regulatory Authority
ESMAP	Energy Sector Management Assistance Program
ESSP	Energy Sector Strategic Plan
EU	European Union
GB	Grand Bargain
GBV	Gender-Based Violence
GCR	Global Compact on Refugees
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GGCRS	Green Growth and Climate Resilience Strategy
GPA	Global Platform for Action on Sustainable Energy in Displacement Settings
HDI	Human Development Index
HI	Humanity & Inclusion
ICS	Improved cookstove(s)
ICT	Information and Communication Technology
IOM	International Organization for Migration
ITCZ	Intertropical Convergence Zone
KII	Key Informant Interview(s)
KYC	Know Your Customer
LC	Local Council
LC1	Local Council 1
LC3	Local Council 3

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LIT	Literature Research
LPG	Liquefied Petroleum Gas
MAP	Geotagging and Co-mapping
MEMD	Ministry of Energy and Mineral Development
MEPI	Multidimensional Energy Poverty Index
MINEMA	Ministry in Charge of Emergency Management
MININFRA	Ministry of Infrastructure
NDP	National Development Plan
NGO	Non-Governmental Organization
NIDA	National Identification Agency
NISR	National Institute of Statistics of Rwanda
NST-1	National Strategy for Transformation
NST2	Second National Strategy for Transformation
OIOS	United Nations Office of Internal Oversight Services
OPM	Office of the Prime Minister
PAR	Participatory Action Research
PAYG	Pay-As-You-Go
PFR	Prison Fellowship Rwanda
PPP	Purchasing Power Parity
PUE	Productive Use of Energy
PV	Photovoltaic
RBF	Results-Based Financing
READS	A roadmap for energy access in displacement settings
RE4R	Renewable Energy 4 Refugees
REA	Rural Electrification Agency
REF	Refugee Engagement Forum
REG	Rwanda Energy Group
ReHoPE	Refugee and Host Population Empowerment Strategy
REP	Renewable Energy Policy
RISE	Regulatory Indicators for Sustainable Energy
RNP	Rwanda National Police
RSEA	Refugee Settlements Electricity Access
RURA	Rwanda Utilities Regulatory Authority
RWC	Refugee Welfare Committee
RWC1	Refugee Welfare Committee 1
RWC3	Refugee Welfare Committee 3
RWF	Rwandan Franc
SBCC	Social and Behaviour Change Communication
SCI	Save the Children International

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SDG	Sustainable Development Goal
SDG 7	Sustainable Development Goal 7
SERP	Sustainable Energy Response Plan
SGBV	Sexual and Gender-Based Violence
SHS	Solar Home System
SILC	Savings and Internal Lending Community
SSQ	Semi-Structured Questionnaire
SUNNY	Sustainable Energy Systems for Refugee and Host Communities in Africa
UASC	Unaccompanied or Separated Children
UBOS	Uganda Bureau of Statistics
UGX	Ugandan Shilling
ULEARN	Uganda Learning, Evidence, Accountability and Research Network
UN	United Nations
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNITAR	United Nations Institute for Training and Research
USD	United States Dollar
WASH	Water, Sanitation and Hygiene
WB	World Bank
WFP	World Food Programme
WHO	World Health Organization
WVI	World Vision International

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TERMINOLOGY

This Terminology glossary provides definitions and descriptions of key terms and concepts used throughout this deliverable in relation to displacement contexts and access to energy. Because several of these terms are interpreted differently across organizations, disciplines, and country contexts, the definitions compiled here establish a common working understanding for SUNNY and support consistent use of terminology across partners and across the two demonstration locations. It is intended as a quick reference and can be consulted whenever interpretation of results or comparisons between refugee and host communities depend on specific wording or conceptual distinctions.

Relevant glossaries in this context of displacement have been developed by different organizations. As these lack a harmonization, the use in this document is clarified below, following primarily the definitions of the IOM glossary [1] and the glossary developed by UNHCR [2].

Refugee: „A person who, owing to a well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it. [1, p. 171]

Internally displaced persons: „Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border.
Source: Guiding Principles on Internal Displacement, annexed to United Nations Commission on Human Rights, Report of the Representative of the Secretary-General, Mr Francis M. Deng, Submitted Pursuant to Commission Resolution 1997/39, Addendum (11 February 1998) UN Doc E/CN.4/1998/53/Add.2, 6.“ [1, p. 109]

Refugee camp: „A plot of land temporarily made available to host refugees in temporary homes. UNHCR, host Governments and other humanitarian organizations provide essential services in refugee camps including food, sanitation, health, medicine and education. These camps are ideally located at least 50 km away from the nearest international border to deter camp raids and other attacks on its civilian occupants.“ [2]

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Refugee settlement: „Settlements in the Ugandan context are areas assigned for refugee settlement by the Government of Uganda. The settlements, located in rural regions, are managed by the Office of the Prime Minister (OPM) with the support of UNHCR. Uganda hosts a total of 13 settlements, accommodating over 1.7 million refugees, as part of its progressive refugee policy, which allows refugees to access land for agriculture, work, and move freely within the country." [3, p. 16], [4]

Host community: "A community that hosts large populations of refugees or internally displaced persons, whether in camps, integrated into households, or independently." [2]

Protection: „All activities aimed at obtaining full respect for the rights of the individual in accordance with the letter and the spirit of the relevant bodies of law (i.e. Human Rights law, International Humanitarian Law, Refugee law).
Source: Inter-Agency Standing Committee, Protection of Internally Displaced Persons: Inter-Agency Standing Committee Policy Paper (December 1999) p. 4." [1, p. 161]

Energy services : "Energy services are those functions performed using energy which are means to obtain or facilitate desired end services or states." [5, p. 129]

Access to energy: The term 'access to energy' is not without its ambiguities; it is often taken to imply the existence of a state of availability of modern energy services, or of the means to access them. Given the considerable variation in the forms and levels of access to energy, a multi-tier framework for access to energy for electricity and cooking, developed by the World Bank and the World Health Organization (WHO), is presented below (**Error! Reference source not found.** and **Error! Reference source not found.**) [6]:

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Table 1: Multi-Tier Framework for measuring access to electricity, copied from [6, p. 7]

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Capacity (power capacity ratings)		<3W	3W–49W	50W–199W	200W–799W	800W–1999W	≥2kW
Availability	Day	<4 hrs	Min 4 hrs		Min 8 hrs	Min 16 hrs	≥23 hrs
	Evening	<1 hr	Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	
Reliability	(Frequency of disruptions per week)	>14				4–14	≤3
	(Duration of disruptions per week)					>2 hrs (if frequency ≤3)	≤2 hrs
Quality (voltage problems affect the use of desired appliances)		Yes				No	
Affordability (cost of a standard consumption package of 365 kWh/year)		≥5% of household expenditure (income)			<5% of household expenditure (income)		
Formality (bill is paid to the utility, pre-paid card seller, or authorized representative)		No				Yes	
Health and Safety (having past accidents and perception of high risk in the future)		Yes				No	

Table 2: Multi-Tier Framework for Measuring Access to Modern Energy Cooking Solutions, copied from [6, p. 75]

Attribute	Measurement Indicators	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Exposure	ISO's voluntary performance targets on emissions-default ventilation						
	$PM_{2.5}$ (mg/MJd)	>1030	≤1030	≤481	≤218	≤62	≤5
	CO (g/MJd)	>18.3	≤18.3	≤11.5	≤7.2	≤4.4	≤3.0
	High ventilation						
	$PM_{2.5}$ (mg/MJd)	>1489	≤1489	≤733	≤321	≤92	≤7
	CO (g/MJd)	>26.9	≤26.9	≤16.0	≤10.3	≤6.2	≤4.4
	Low ventilation						
	$PM_{2.5}$ (mg/MJd)	>550	≤550	≤252	≤115	≤32	≤2
	CO (g/MJd)	>9.9	≤9.9	≤5.5	≤3.7	≤2.2	≤1.4
Efficiency	Stove efficiency, using ISO's voluntary performance targets (%)	<10	≥10	≥20	≥30	≥40	≥50
Convenience	Fuel acquisition and preparation time (hours/week)	≥7		<7	<3	<1.5	<0.5
	Stove preparation time (minutes/meal)	≥10			<10	<5	<2
Safety	Severity of accidents caused by the stove over the past year	Serious			Minor	None	
Affordability	Fuel cost as a share of household expenditure (%)	≥10			<10	<5	
Availability	Ready availability of primary fuel when needed (% of the year)	≤80			>80	>90	100

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EXECUTIVE SUMMARY

Deliverable D1.1 provides the contextual evidence base developed under SUNNY Task 1.1 to support the design of sustainable and context-appropriate energy solutions for refugee and host communities in Uganda and Rwanda. It brings together desk-based and field-based research in order to examine the local conditions, community perspectives, environmental resource potentials, and regulatory and policy frameworks that shape energy access in the two demonstration contexts.

The deliverable consists of one main document and three additional stand-alone documents. The main document presents the overarching analytical framework and synthesises the principal findings across the different components of the contextual analysis. It is complemented by three additional documents: a Uganda context survey results report, a Rwanda context survey results report, and a dedicated desk review report for the regulatory and policy analysis. These additional documents form an integral part of Deliverable D1.1 and provide the full results of the context surveys and desk review at a level of detail that could not be accommodated in the main report without affecting its overall readability and balance.

The main document is structured around four complementary components. First, the system-centred description provides an overview of the broader contextual conditions in the demonstration settings, including the national and local context, displacement settings, energy landscape, relevant actors, and available data sources. Second, the person-centred analysis examines community perspectives through participatory workshops and household surveys, with particular attention to daily life, wellbeing, and access to energy services. Third, the environmental analysis considers local resource potentials and circularity-related conditions, with a current focus on waste and biowaste streams in Bidibidi Refugee Settlement and the surrounding host communities. Fourth, the regulatory and policy analysis assesses the enabling environment for sustainable energy interventions through key-informant interviews and a desk review of relevant policy, regulatory, and institutional frameworks.

Taken together, the main document and the three accompanying reports provide a multi-dimensional understanding of energy access in displacement contexts. The findings demonstrate that energy access must be understood not only as a technical matter, but also in relation to social diversity, livelihoods, environmental conditions, governance structures, and the interaction between humanitarian and development systems. In this respect, Deliverable D1.1 establishes an important foundation for subsequent SUNNY activities, including solution design, stakeholder engagement, demonstration planning, and further analytical and implementation-oriented work.

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I. INTRODUCTION

This chapter provides an entry point to Deliverable D1.1 by framing both the broader project context and the purpose of the contextual analysis documented in this report. It first introduces the SUNNY project's overall objectives and approach to strengthening access to sustainable energy services in rural and displacement-affected settings in Rwanda and Uganda. It then outlines the objectives and scope of the contextual analysis under Task 1.1, clarifying how the mixed-methods evidence base supports the development of context-appropriate solutions and informs subsequent activities across the project. Finally, the chapter explains how this deliverable is structured, guiding the reader through the main sections and highlighting how the different components fit together to support readability.

1. General Background to the SUNNY project

The overall objective of the SUNNY project is to sustainably improve access to energy services for rural and displaced communities in Rwanda and Uganda by generating innovations in the respective energy environments. The project applies an integrated approach to address energy needs comprehensively and based on the circular economy concept, develop supporting systems that complement existing local value-chains. On a local level, interventions are tailored to the respective contexts by means of a co-design process. On an institutional level, the replication of the developed innovations is systemically advanced. The project is composed of a diverse project consortium to facilitate the wide scope of activities.

Gathering 17 partners from 3 African, 5 European countries and 2 associated countries, SUNNY is a 48-months project that aims to provide highly replicable solutions for green energy transition and energy access in Africa. To reach that goal, five Renewable Energy Technologies, reaching TRL 7-8 will be improved, adapted to the local context and demonstrated in two sites in Uganda and Rwanda, reaching around 1300 refugees and persons in the local host populations.

The technologies developed in SUNNY will be upgraded following circular economy and local value chain approaches in order to create economic activity locally as well as ensure relevance of the solutions and long-term sustainability. To ensure uptake, a strong focus will also be made on cost effectiveness and adapted business models. Solar home systems will ensure the access to basic energy needs at a household level (PR1). Clean hydrogen (PR2) and biogas (PR3) cooking solutions will allow cooking to be decarbonised while improving health conditions. Refrigerated food storage (PR4) and smart solar irrigation, combined with biogas, will allow to improve food security in rural

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African areas and address the WEF nexus. Holistic models (PR5) and assessment methods (PR8) will allow to identify and validate the benefits and sustainability of the technologies, while social innovation through among others capacity building will support the long-term socio-economic impact (PR6) and ensure local uptake as well as a strong replicability potential. Indeed, SUNNY ambitions to widely impact humanitarian energy practices through a replication plan comprising the involvement of 15 replication cases with new interoperability of technologies, training activities towards African and EU-wide energy-access and development agencies and camps managers, and policy recommendations (PR8).

2. Introduction to the context analysis

This section introduces the context analysis conducted under Task T1.1 and explains its purpose within Deliverable D1.1. It briefly outlines the scope of the analysis across the two demonstration locations and clarifies how the work combines complementary components. The section also explains how the context analysis supports subsequent SUNNY activities by providing a structured evidence base for solution development, implementation planning, and later monitoring and evaluation.

2.1. Objective of the context analysis

Task 1.1 focuses on establishing a comprehensive understanding of the local contexts and regulatory frameworks that shape energy access in both host communities and refugee settlements in Rwanda and Uganda. The task aims to generate a comprehensive evidence base that reflects multiple dimensions and conditions in the two demonstration locations, as well as the policy and regulatory environments that govern energy-related interventions in humanitarian and rural settings.

To achieve this, the task structured into two complementary subtasks. Subtask 1.1.1 conducts a holistic assessment of local conditions using a mixed-methods approach that combines preparatory desk research with quantitative surveys and qualitative methods. Subtask 1.1.2 examines national and local policy and regulatory frameworks, identifying variations between host communities and refugee settlements and analysing their implications for the development of tailored SUNNY solutions. Together, these subtasks provide the foundational knowledge required for informed solution design, continuous data acquisition, monitoring, and subsequent policy recommendations across the SUNNY project. The results of Task T1.1 are documented in this deliverable.

Overall, the main objective of this deliverable is to provide insights into the energy space in Rwanda and Uganda. This includes establishing a comprehensive understanding of

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factors influencing access to energy services. The aim of the comprehensive context analysis is to follow a holistic approach that takes the complex interrelation of energy and other sectors into account.

Deliverable D1.1 encompasses a comprehensive analysis of the local contexts covering energy-related local conditions and an analysis of local regulations and policies. The three pillars that contribute to the context analysis. The three pillars are depicted in Figure 1.

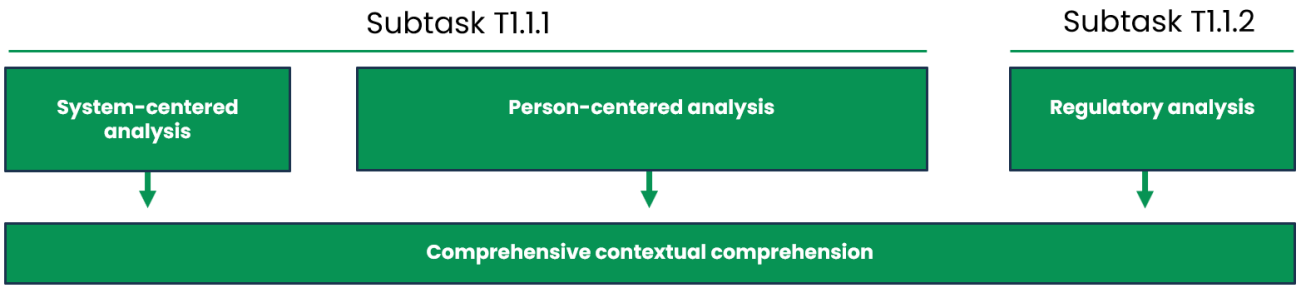

Figure 1: Conceptual pillars and methodological approach of SUNNY Task 1.1

2.2. Contribution of the context analysis to the SUNNY project

The context analysis carried out under Task 1.1 provides the evidence base that enables SUNNY to design, tailor, and implement its solutions in a way that is grounded in local realities in both Rwanda and Uganda. Building on the project's premise that effective energy interventions in rural and displacement-affected settings require an in-depth understanding of the local context, the context analysis supports the identification of requirements and the definition of use cases by combining a three-level analytical perspective: (i) person-centred mapping of energy access, strategies, preferences, and capacities; (ii) systemic description of existing infrastructure, and programs; and (iii) a study of the regulatory and policy conditions

Beyond informing design choices, the context analysis establishes a structured foundation for the project's broader implementation and learning architecture. It guides the development of common standards for data collection.

The analysis supports downstream work on circularity and local value chain development (e.g., by informing upstream assessments that underpin later value chain definition activities), and it contributes to the project's monitoring system during demonstration activities (T5.2).

The regulatory and policy dimension of the context analysis (Subtask 1.1.2) strengthens SUNNY's ability to ensure feasibility and longer-term uptake. By identifying regulatory

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frameworks and variations between host areas and refugee settings, the analysis complements market screening (T7.1) and provides a basis for updated analysis and the subsequent development of evidence-based policy recommendations in T6.4.

2.3. Contribution of the contextual beyond the SUNNY project

In the early phase of the work in Task T1.1 the partners involved identified a significant scientific and practical value in expanding the scope of the analysis to be conducted in Task T1.1 and in extension WP1. The SUNNY project is pioneering novel conceptual approaches that focus on a holistic contextual understanding and systematically integrating the local communities throughout the innovation process. The project is positioned to make a substantial contribution to advancing research in this field. This is particularly significant given that displacement settings, and even more so the domain of energy access within these settings, are characterized by a fundamental lack of conceptual clarity and a limited evidence base. The initial submission date for Deliverable D1.1 was M12. Following consultation with the European Commission, the deliverable's submission date was shifted to M22 to facilitate the expansion of the scope of the work conducted.

The comprehensive work conducted in Task T1.1 has the potential to make significant scientific contributions to the field, presenting a high impact potential beyond the SUNNY project. The scientific potential of the work conducted in Task T1.1 is further reflected in the publications planned to emerge from this task. In total, at least five scientific publications are foreseen.

3. STRUCTURE OF THE DELIVERABLE

Deliverable D1.1 is structured to guide the reader through the context analysis in a clear and logical way, moving from the broader framing of the work to the detailed analytical components and, finally, to the main conclusions. Following the introductory chapter, Chapter II presents the overall methodology and explains the analytical logic underpinning Deliverable D1.1. Chapter III provides the system-centred description and sets out the broader contextual conditions in the demonstration settings. Chapter IV presents the person-centred analysis, bringing together the findings from participatory workshops and the context survey. Chapter V contains the environmental analysis, with a focus on resource potentials and circularity-related conditions. Chapter VI sets out the regulatory and policy analysis, including both the interview-based and desk-based components. Finally, Chapter VII brings the different strands of the deliverable together in a holistic assessment, summary, and outlook.

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In addition to the present main document, Deliverable D1.1 comprises three accompanying stand-alone documents that form an integral part of the overall deliverable package: the Uganda context survey results report, the Rwanda context survey results report, and the dedicated desk review report on the analysis of policies and regulations. This document architecture was chosen to keep the main report focused on the overarching analytical framework and synthesis, while making the detailed country-specific survey results and the full desk-review results available in separate reports. To further support readability and ease of consultation, literature lists are provided separately for individual chapters or sections, where appropriate.

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II. OVERALL METHODOLOGY

This chapter provides an overview of the methodological approach underpinning Deliverable D1.1 and explains how the different activities under Task T1.1 are brought together into a coherent context analysis. It first presents the overall methodological logic and the main analytical components used to structure the work, highlighting how desk-based synthesis and field-based evidence generation are combined across the two demonstration locations. The chapter then serves as a guide for the reader: while it offers a common framing to improve overview and readability, the specific methods applied for each component of the deliverable are described in more detail in the respective chapters of this report.

1. DESCRIPTION OF THE OVERALL METHODOLOGY

The objectives of Task T1.1 are broad in scope and require integrating evidence from different perspectives and methodological traditions. To structure the work systematically the overall methodology combines desk-based synthesis with field-based evidence generation. In practice, this means that literature and data reviews are complemented by empirical data collection in and around the demonstration sites, enabling the deliverable to capture both system-level conditions (e.g., infrastructure, institutions, programs, markets) and community-level realities (e.g., lived experiences, needs, practices, and capacities). The overall approach is designed to support the development of context-appropriate SUNNY solutions by grounding subsequent project activities in a robust understanding of local conditions.

For clarity and readability, the work under Task T1.1 is organized into four complementary components, each contributing distinct analytical insights toward the overarching aim of developing a holistic understanding of the local context. These four components are visualized in Figure 2 and are briefly introduced in the subsequent section: (i) a system-centred description of the broader context based primarily on literature and field observations; (ii) a person-centred analysis that documents perspectives from refugee and host communities through participatory methods and survey-based evidence; (iii) an environmental analysis focusing on resource potentials and circularity (including waste and biowaste flows); and (iv) a regulatory and policy analysis examining the enabling environment for energy interventions.

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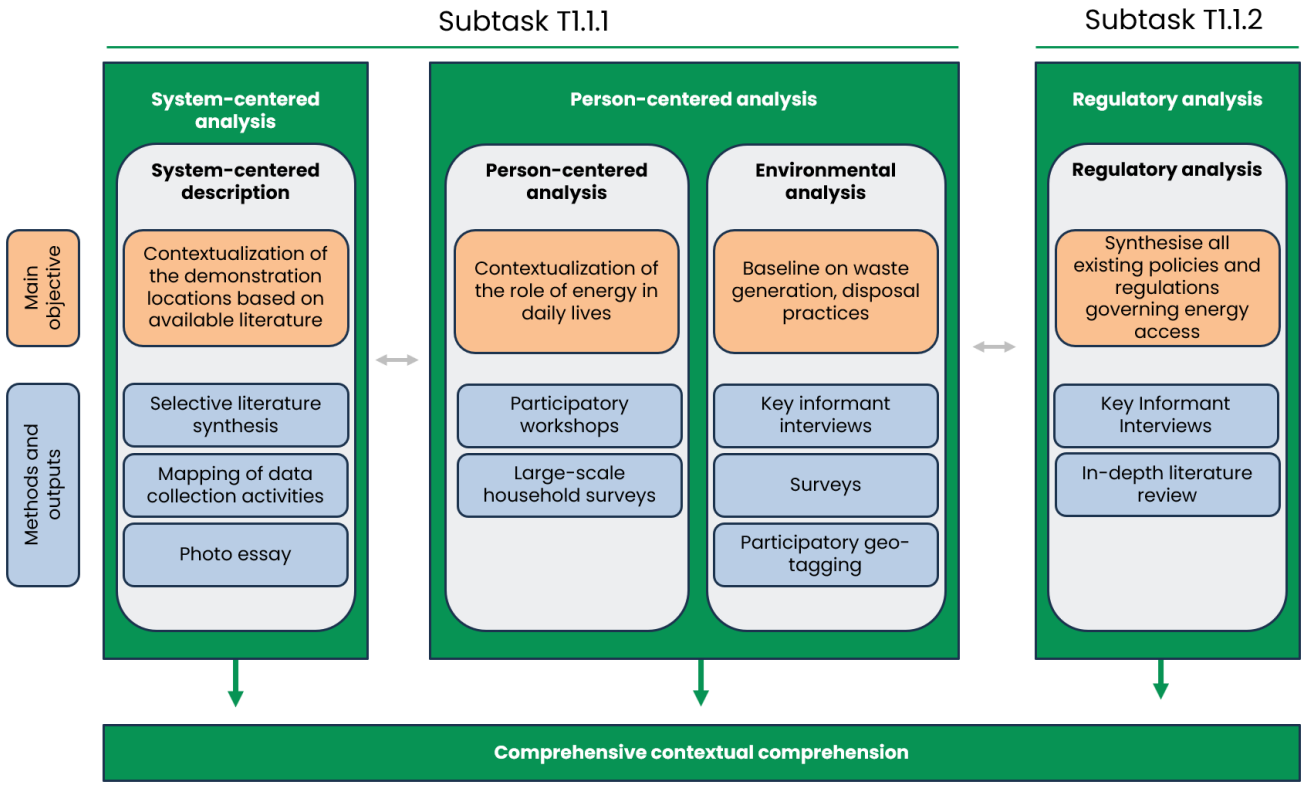

Figure 2: Overview of the overall methodology of Task T1.1

2. Short description of the components of the context analysis

As visualized in **Error! Reference source not found.**, the work in Task T1.1 is structured in four main components. To improve the readability of this preliminary deliverable, in the following we present an overview of the four components, including the status.

This section provides a high-level orientation only: the specific methods, instruments, sampling approaches, and analytical procedures applied within each component are described in more detail in the respective chapters of this report. This structure is intended to improve overview and navigation, while allowing each component to present its methodology with the level of detail appropriate to its evidence base and outputs.

2.1. System-centred description

Introduction: This component of the deliverable provides a provide a comprehensive contextual description covering multiple dimensions and layouts. It presents an overview of the demonstration countries and the demonstration locations and provides a general overview of the context based on both scientific and grey literature. Further it includes images of the demonstration location taking furring fields visits for further contextualization.

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Objective: The objective of this chapter is to lay a foundation for both the SUNNY project and the subsequent parts in this deliverable. The Chapter system-centred analysis can be understood as both a background chapter for this report and a description of the local context on a system level. The main objective is to enable a contextualization of the demonstration locations based on available literature. The description of the local covers two geographical levels – the national level, and the camp/ settlement level.

Methods: A selective and interpretive synthesis of existing literature was conducted to support the background of this report. Key studies and relevant sources were identified and thematically organized based on their contribution to the topic, rather than according to exhaustive or rigid inclusion criteria. The focus was on summarizing and contextualizing the literature to build conceptual clarity, rather than aiming for comprehensive coverage or systematic appraisal. The consolidation of existing literature was supplemented by mapping of relevant data collection activities previously implemented in the demonstration locations and a photo essay. The photos included in the photo essay were taken during several field visits to the demonstration locations and are complemented with descriptions based on observations in the fields and exchanges with local actors during the field trips.

Main activities and results: The main activities as part of the system-centred description include a through literature and data review to identify relevant literature for the description of the contexts. The literature review forms the basis for the context description included in this deliverable. Further, the referenced literature may serve as a reference point for subsequent activities in the SUNNY project.

Link to other activities in the project: This component of the deliverables provides the literature-based description of the context. It complements the person-centred analysis of this report. The context description contributes to the formulation of the use cases (Task T1.4) and the specification of the SUNNY technologies in WP3.

2.2. Person-centred analysis

Introduction: From a scientific point of view, the person-centred analysis presents the main body of this deliverable. The person-centred analysis covers goes beyond the description of the local energy ecosystem and aims at uncovering and documenting the perspectives of the local communities. This component of the deliverable aims as systematically establish an understanding of the underlying challenges that energy services can address, and a basic understanding of the diversity of perspectives on subject matters related to energy access. The person-centred analysis therefore addresses the fundamental gap of a lack of integrating local perspectives in developing

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energy introduce in displacement contexts.

Objective and research question addressed: The main objectives of the person-centred analysis is to establish an understanding of energy-related themes from the perspective of the local communities. Specifically, the research questions addressed in this component of the deliverable include (1) establishing an understanding of the role of energy services contribute to the daily functioning and quality of life, and (2) uncovering energy service needs and local capacities to facilitating an enhanced access to energy services. Beyond the content-related objectives, this person-centred analysis aims for advancements in participatory research both in the SUNNY project and beyond.

Methods: The person-centred analysis follows a mixed-methods approach. Methodically the two main components of the approach cover (1) a series of workshops conducted with representatives of the local refugee and host communities in the demonstration locations, and (2) a large-scale data collection activity that is conceptualized and informed by the results derived from the workshops. The data collection activity coves 700 households in total and is applied to translate qualitative findings from the workshops into quantitative insights.

Main activities and results: The workshops conducted in Mahama and Bidibidi allow for diverse insights into the local context that are not accessible through desk-based research. The documentation of the workshops enables concrete insights into local challenges, diverse perspectives on the role of energy, energy needs and implications of access to energy in the local contexts. Based on the comprehensive insights from the workshops, the large-scale quantitative data collection exercise was conceptualized and implemented.

Link to other activities in the project: The results of the person-centred analysis, as well as the learnings from implementing the participatory research activities directly feed multiple subsequent tasks and work packages. The results directly feed into the development of the SUNNY innovations in WP3, the local stakeholder engagement in WP2 and financial and business considerations in WP7.

2.3. Environmental analysis

Introduction: The analysis highlights both the risks associated with current mismanagement and the opportunities to integrate biowaste valorisation into sustainable energy systems. While household-level solutions face barriers, targeted interventions at clustered community scales can deliver more environmental benefits, enhance sanitation, and potentially create livelihood opportunities through circular

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value chains.

Objective and research questions addressed: Deliverable D1.1 aims to establish a comprehensive baseline on waste generation, disposal practices, and the potential for biowaste valorisation in refugee settlements and host communities, with a focus on Bidibidi, Uganda. The research paper addressed three questions: (1) What types of biowaste are produced in the target area? (2) How are these waste streams currently managed or valorised? (3) What is the potential to integrate biowaste into sustainable energy and circular waste management systems?

Methods: A mixed-methods approach was applied, combining semi-structured questionnaires, key informant interviews, field assessments, geo-tagging, and literature review. A system-centred approach was used to map overall waste flows, while a person-centred approach captured household-level and community-level practices and perceptions. This mix enabled a deeper understanding of environmental risks and opportunities.

Main activities and results: REFUSE, supported by CTEN, completed a mapping of local waste flows in Bidibidi and surrounding host communities. Findings confirmed widespread mismanagement practices such as indiscriminate dumping and open burning, which directly undermine environmental health and human well-being. The study clustered biowaste into four main categories: household/cooking waste, livestock waste, agricultural waste, and human waste (latrines, wastewater treatment). Current reuse practices, including composting, livestock feeding, and briquette-making, were documented, but volumes remain small and scattered. Opportunities for anaerobic digestion were analysed at three scales of biodigesters, with results showing limited feasibility at household level due to low yields and dispersed feedstock, but higher potential in institutions (schools, health centres) and clustered farming households where concentrated streams and energy demand converge.

Link to other activities in the project: These findings provide critical input for Task 1.3 and 1.4, supporting socio-technical scenario building and regulatory analysis, while also feeding WP2 (design of circular value chains) and WP3 (eco-design and technology upgrades). The environmental baseline underpins WP5 monitoring indicators and WP6 evaluation frameworks.

2.4. Regulatory analysis

Introduction: This component of D1, developed in response to sub-task 1.1.2, provides a comprehensive overview of the regulatory and policy frameworks shaping energy provision in displacement contexts in Rwanda and Uganda. By analysing existing

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structures governing energy access, we aim to identify key barriers and opportunities for advancing sustainable and inclusive energy solutions and thus seek to inform strategies to align humanitarian and national energy policy approaches.

Objective and research questions addressed: The regulatory analysis has two main objectives, namely, to synthesise all existing policies and regulations governing energy access in displacement contexts in Rwanda and Uganda, and to qualitatively explore stakeholder perceptions on how policies and regulations influence the provision of energy in displacement contexts in Bidibidi and Mahama.

Three main research questions will be addressed:

1. How do national-level policies and regulations shape the provision of energy access in displacement contexts?
2. What gaps exist within the current policy and regulatory frameworks governing energy access in displacement contexts?
3. Which bottom-up or informal processes fill these gaps?

Methods: The research questions were explored through interviews with key informants from Rwanda and Uganda and a comprehensive desk review of all relevant policies and regulations. The key informant interviews were conducted with national-level stakeholders. The desk review encompassed a content analysis of the most important policies as well as an analysis of the academic literature on the subject more broadly.

Main activities to date and results: An initial literature review revealed that to date, no comprehensive assessment of policies and regulations on energy provision in displacement contexts has been carried out for Rwanda or Uganda. Building on initial insights a mixed-methods methodology was developed and implemented to integrate interview-based data collection and structured and systematic in-depth literature reviews.

Link to other activities in the project: The results of the analysis will facilitate the implementation of forthcoming SUNNY activities and will contribute directly to D6.4 Policy Recommendations and D7.4 Market Assessment.

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III. SYSTEM-CENTRED DESCRIPTION

This chapter documents the system-centred description by consolidating key system-level information (e.g., national and site profiles, displacement context, energy access conditions, relevant actors and initiatives, and an overview of energy projects). It is one out of the four components contributing to comprehensive contextual comprehension, as visualized in Figure 3.

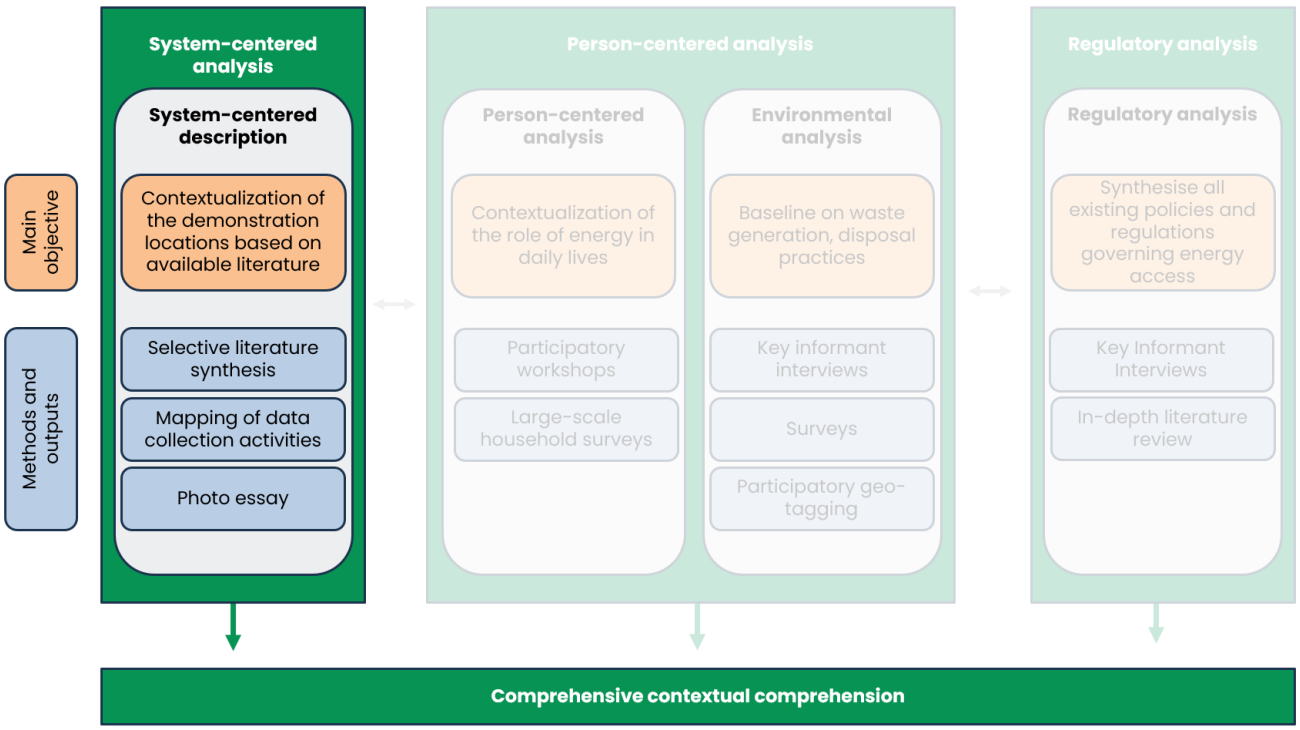

Figure 3: System-centred Analysis as part is one component in the overall methodology.

1. INTRODUCTION

This chapter offers an overview of the general background of the context in which the SUNNY project operates, considering both the broader national contexts and the local demonstration sites. Thereby, it presents a comprehensive overview of the general geographic contexts and national displacement contexts in Uganda and Rwanda, as well as an introduction to the two demonstration sites, the Bidibidi Refugee Settlement in Uganda and the Mahama Refugee Camp in Rwanda. It provides a description of the demonstration site's state of access to energy, an overview of local energy projects, and the current state of research in this field.

Objectives:

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The objectives of this chapter are to (i) provide a structured overview of national and site-level context factors relevant to energy access in the two demonstration locations; (ii) summarize key characteristics of the displacement contexts and the demonstration sites that influence service provision and infrastructure development; (iii) describe the current state of access to energy (with a focus on electricity and cooking) at country and site levels; (iv) map relevant actors in and around the demonstration sites and map relevant previous data collection activities.

Structure of the Chapter

To support readability, this chapter is organized into six parts. It starts with a description of the methodological approach used for the desk-based synthesis and field observations. It then introduces the demonstration contexts at national and site level for Uganda and Rwanda, including the displacement contexts and the two demonstration sites. Building on this baseline, the chapter summarizes the state of access to energy in the demonstration countries and at site level, provides an overview of relevant data sets, and closes with a photo essay that visually contextualizes the local environments and energy landscape.

2. Methods

Literature synthesis: The system-centred description is based on a selective and interpretive synthesis of existing academic and grey literature. Sources were identified through targeted keyword searches and were then screened for relevance to the national contexts of Uganda and Rwanda, displacement governance and settlement/camp characteristics, and energy access and the local energy ecosystem in and around Bidibidi Refugee Settlement and Mahama Refugee Camp. Rather than applying exhaustive inclusion criteria, the review prioritised key studies, datasets, and institutional publications that contribute to conceptual clarity and contextual understanding. The consulted sources were thematically organised (e.g., geography and climate, demographics and socio-economic indicators, displacement context, energy access and infrastructure, key actors and initiatives) and synthesised across national and site levels. The full list of consulted references is provided in the section-specific literature section. The literature synthesis is presented in two separate sections. The first section introduces the context and the second section introduces the energy landscape in the context.

Mapping of energy projects: To complement the desk-based synthesis, a mapping of relevant energy data collection activities previously implemented in and around the demonstration locations was compiled based on project documents, publicly available reports, and available information shared by local actors.

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Photo essay: Finally, the literature-based description is complemented by a photo essay. A photo essay is used as a visual method to contextualise a setting by presenting photographs that capture everyday practices and key elements of local infrastructure and environments. The photographs were taken during several field visits to the demonstration locations and are accompanied by short descriptions based on direct observations and exchanges with local actors. Together, the images and accompanying text provide a visual narrative that complements and enriches the written synthesis.

3. Introduction to the demonstration context

In the following, the geographical contexts of the SUNNY's two demonstration sites, the Bidibidi Refugee Settlement in Uganda and the Mahama Refugee Camp in Rwanda, will be presented. First, the national contexts in which the demonstration sites are embedded will be elaborated, including information on prevailing climatic conditions, demographic profile, and economic standing. Furthermore, the geographical distribution, origins and composition of the population groups affected by displacement will be shown on a national level. The most prominent local actors in the field of energy access will be identified for both countries. Finally, an introduction to the two demonstration sites, will be given.

Frist, this section introduces Uganda, its displacement situation and the demonstration location Bidibidi Refugee Settlement. The Bidibidi Refugee Settlement is located in the North-West of Uganda on the border to South Sudan.
Second, this section introduces Rwanda, its displacement situation and the demonstration location Mahama Refugee Camp. The Mahama Refugee Camp is located in the South-East of Rwanda on the border to Tanzania.

3.1. Uganda

3.1.1. Introduction to Uganda

The Republic of Uganda is located in East Africa, bordering borders South Sudan to the North, Kenya to the East, Rwanda and Tanzania to the South, and the Democratic Republic of the Congo to the West (**Error! Reference source not found.**Figure 4**Error! Reference source not found.**). Uganda is a landlocked country, with lakes forming much of its border, most notably Lake Victoria in the South-East, on the shore of which Uganda's capital Kampala is located. Uganda lies in the Northern part of the African Great Lakes system and the Nile basin. Covering an area of 241,038 km², the country is crossed by the Equator and has an average elevation of 1,100 meters above sea level. The majority of Uganda consists of a plateau, bordered by mountain ranges and valleys, gradually declining toward the north [1], [2],[3].

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Figure 4: Map of the Republic of Uganda, [3]

English and Kiswahili are the official languages, whilst over 40 languages are spoken in Uganda, of which widely spoken regional languages include Luganda and Ganda. Uganda gained independence on 9 October 1962. It is a presidential republic, with Yoweri Kaguta Museveni serving as president since 1986. The Prime Minister, currently Robinah Nabbanja (since 2021), heads the government, while legislative authority rests with the Parliament of Uganda [1],[2].
Uganda is divided into 146 districts. The SUNNY project is implemented in the Bidibidi settlement, which is located within the Yumbe district in the North of Uganda.

Climate

Uganda's climate is mostly classified as tropical savannah, - rainforest and – monsoon climate after the Köppen-Geiger system (Figure 5**Error! Reference source not found.**). Nevertheless, local climate variations occur, which are influenced by the country's topography, including elevation and the presence of lakes. Located on the equator, the country receives approximately 12 hours of daylight daily, with minimal variation in solar declination at midday. Prevailing winds are generally from the northeast and southwest, and cloud cover shows little seasonal fluctuation, contributing to a stable year-round climate [2], [3].
Precipitation is generally well distributed, ranging from around 500 mm annually in the northeast to 2,000 mm near Lake Victoria. In the northern regions, the wet season spans April to October, followed by a dry season from November to March. The south

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experiences two wet seasons—from April to May and October to November—interrupted by a brief dry period [2], [3]. Tropical thunderstorms occur occasionally across the country.

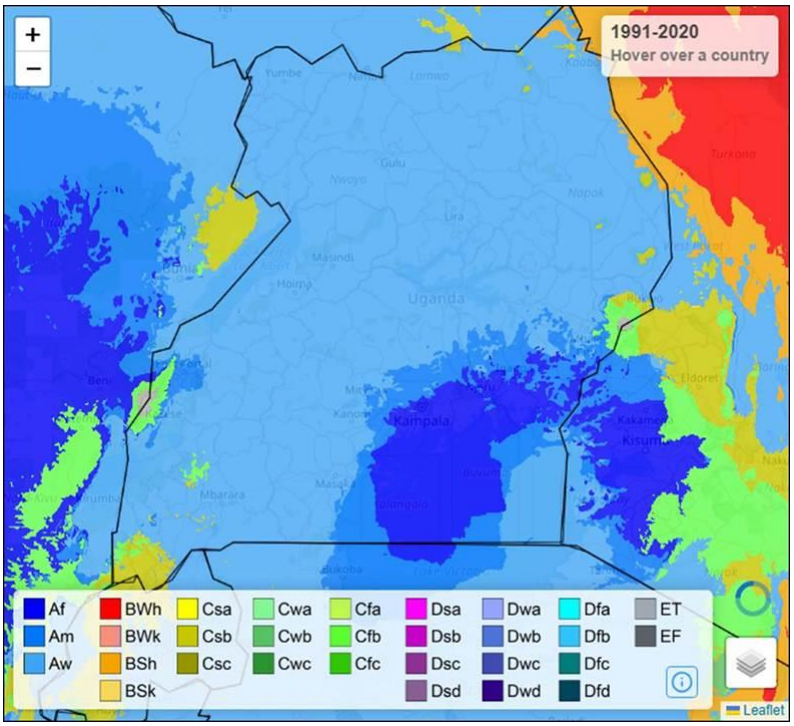

Figure 5: Köppen-Geiger climate classification of Uganda, Aw = Tropical savanna climate, Am = Tropical monsoon climate, Af = Tropical rainforest climate, Cfb = Subtropical highland climates with uniform rainfall, Csb = Warm-summer Mediterranean climate, [4]

Population

Uganda has a population of approximately 49 million inhabitants and a population density of around 200 people per km². Between one quarter and one third of Uganda's population resides in urban areas, while the majority live in rural settings [1], [2]. The capital city Kampala is the country's primary urban centre, home to approximately 3.8 million inhabitants. With an annual growth rate exceeding 3% (2024), the country ranks among the fastest-growing populations globally [3]. Uganda is characterized by significant ethnic diversity, with the Baganda representing the largest ethnic group [1], [2]. The country's religious composition is predominantly Christian (over 80%), split roughly equally between Protestants and Catholics, followed by Muslims (around 13%) and smaller groups adhering to indigenous beliefs [1], [2].

Uganda's age structure follows a distinctly pyramidal profile, reflecting a predominantly young population (Figure 6) [1]. About half of all Ugandans are between 15 and 64 years old, and nearly the other half are children under 14. Only 2.4% of the population is aged 65 or older (2024 est.) [1]. The median age stands at 16.2 years—15.5 for males and 17.1 for females [1]. The average life expectancy at birth is close to 70 years, slightly lower for males (67.5 years) and higher for females (72 years) [1], [2]. Uganda's population growth

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remains high, supported by a total fertility rate of 5.17 children per woman (est. 2024) [1]. The net migration rate is negative at -3.1 migrants per 1,000 people [1].

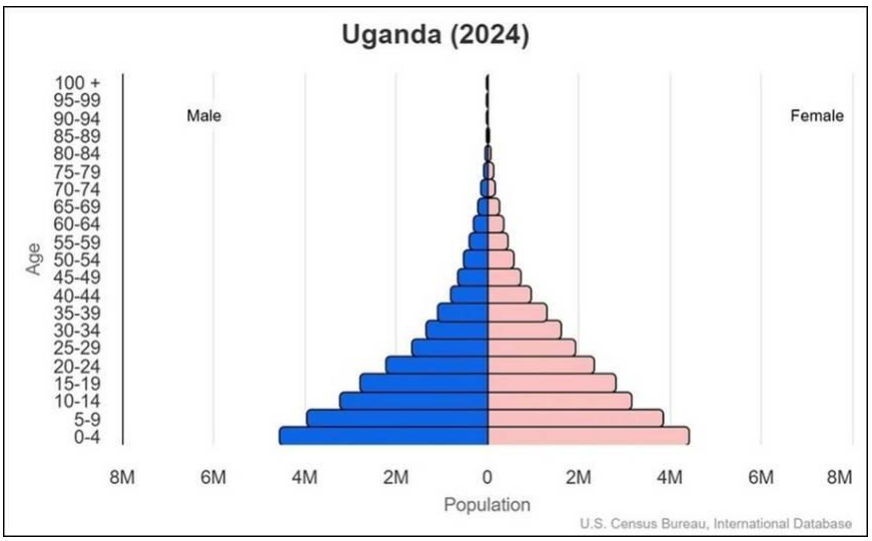

Figure 6: Demographic pyramid of Uganda, [1]

Economy

Uganda is classified as a low-income economy with a predominantly agrarian base. The national currency is the Ugandan shilling (UGX) [1]. Major industries include agriculture and agro-processing, sugar production, brewing, tobacco, textiles, cement, and steel manufacturing. The country's GDP is estimated at approximately USD 54 billion (nominal) and USD 144 billion (PPP), corresponding to a GDP per capita of around USD 1,100 nominal and USD 2,900 (PPP) [1]. Uganda's economic growth rate has shown steady improvement, rising from 4.6% in 2022 to 6.1% in 2024 [1]. Income inequality remains moderate, with a Gini index of 42, while the Human Development Index (HDI) stands at 0.582, both classified as medium [5]. Core inflation has remained stable at around 3% [1], [6]. However, 42% of the population continue to live below the national poverty line [6].

3.1.2. Introduction to the displacement context in Uganda

Owing to a series of regional conflicts, particularly in recent decades, the country has become a major host of refugees within East Africa. Uganda has a total population of just under 50 million people, of whom approximately three quarters live in rural areas and one quarter in urban centres. As of 2024, the country hosts around 1.5 million displaced persons, making it one of the largest refugee-hosting nations in Africa [7],[8]. Nearly 90% of all refugees in Uganda originate from two neighbouring countries – South Sudan and the Democratic Republic of the Congo (DRC). More than half of the total refugee population fled conflict in South Sudan, seeking safety primarily in northern Uganda, while roughly one third come from the DRC. Refugees from other countries such as Somalia, Burundi, Eritrea, and Rwanda represent smaller shares, each below 5%. Other

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nationalities, numbering around 14,000 individuals in total, account for roughly 1% of all refugees [7],[8].
Refugee settlements are distributed across twelve districts, namely Madi Okollo & Terego, Adjumani, Yumbe, Isingiro, Kampala, Kikuube, Obongi, Kyegegwa, Kamwenge, Lamwo, Kiryandongo, and Koboko (listed by descending refugee population). The largest settlements are found in Madi Okollo & Terego (approx. 211,600 refugees) and Adjumani (approx. 210,700), while Koboko hosts the smallest number, around 6,000 displaced persons [7],[8].

The largest number of refugees reside in a cluster of settlements, which is concentrated in the very North-West of Uganda between South Sudan and the Democratic Republic of the Congo. Most refugees residing in these settlements originate from South Sudan, while a smaller share comes from the Democratic Republic of the Congo (DRC). The Bidibidi settlement, which acts as the Ugandan demonstration site for the SUNNY project is located within this region [7].
A second cluster of settlements is located in the southwestern region of Uganda. Here, most refugees originate from the DRC, followed by smaller groups from Burundi, Rwanda, and Somalia. In contrast to the northern region, settlements in the south-west are more dispersed and of relatively similar size. A third area of high refugee concentration is the capital city, Kampala. The urban refugee population is notably diverse, reflecting the city's economic importance and its role as Uganda's administrative centre. The largest group in Kampala originates from Somalia, alongside smaller populations from various other countries [7].

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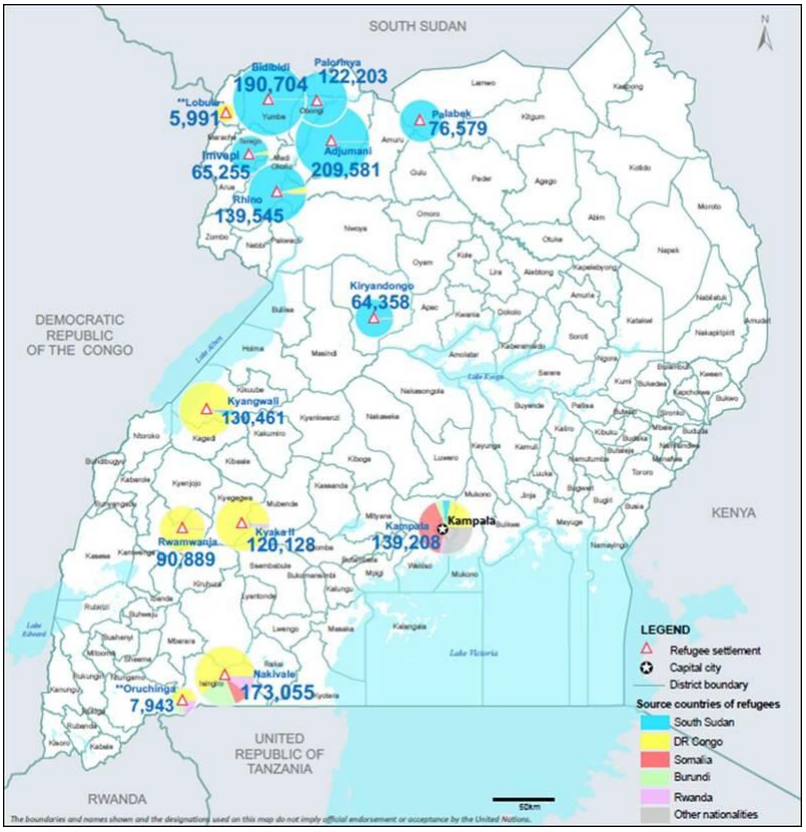

Figure 7: Locations of refugee settlements in Uganda and number of displaced people per settlement and share of their origin as of 30 June 2023, [7]

The balance between refugee and host populations largely depends on the size of the local population in each district. A notable example is the capital city, Kampala, which hosts approximately 145,000 displaced persons—more than in Obongi District. However, due to Kampala's total population of about 1.7 million inhabitants, refugees account for only around 8% of the city's residents. This contrast highlights how population density and settlement patterns influence the relative share of refugees within host communities. The current distribution of refugees across districts raises important questions regarding the adequacy and equity of settlement patterns nationwide [7],[8]. As sources like [9] and [10] state, Uganda is widely recognised for its progressive refugee policy, often cited as a model within the region. A key feature of this approach is the right of refugees to work and, in some cases, to access land for settlement and agricultural use. These provisions enable refugees to rebuild their livelihoods and integrate into local communities. The policy generates benefits for both refugees and host populations, as refugee-led economic activities contribute to local production, trade, and service provision, thereby stimulating economic growth. However, this interaction can also create competition for resources and market opportunities, occasionally leading to tensions between refugees and host communities [11].

Relevant organizations in the context of displacement in Uganda

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The READS summary report provides a comprehensive overview of the regarding main actors in Uganda [8]. A diverse range of organisations are active in refugee settlements in Uganda. The most relevant actors are active in the areas of clean cooking, electricity, and business and community facilities, as summarized below. The primary stakeholders in these fields are humanitarian organizations and private companies (Figure 8Figure 8: Main stakeholders in Uganda regarding clean cooking (left), electricity (middle) and Businesses & community facilities (right), caption: Blue – Humanitarian and development actors, Purple – private companies, [8]Table 23).

Of the humanitarian and development organizations operating in displacement contexts in Uganda, the German Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) is a key actor, with initiatives spanning all areas of clean cooking, electricity, and business and community facilities. Mercy Corps is active in both energy access sectors—clean cooking and electricity. Several organizations focus specifically on clean cooking, including Caritas, Save the Children, and the International Lifeline Fund. In the electricity sector, the International Organization for Migration (IOM) plays an important role. Regarding business and community facility development, Palm Corps and the AVSI Foundation are notable contributors.

A large number of private companies is also engaged in these sectors. In clean cooking, key firms include BM Energy, Clean Environment for Africa, Pesitho, and the Raising Gabdho Foundation. Electricity access involves the largest variety of actors, with prominent companies such as Fena Solar, Village Power, D.Light, Solaraid, Engie Energy Access, and Fres Uganda. Several private actors are also active in business and community facility development within displacement contexts, including Power-Blox, Solar Now, Mandulis Energy, Tulima Solar, and Fres Uganda.

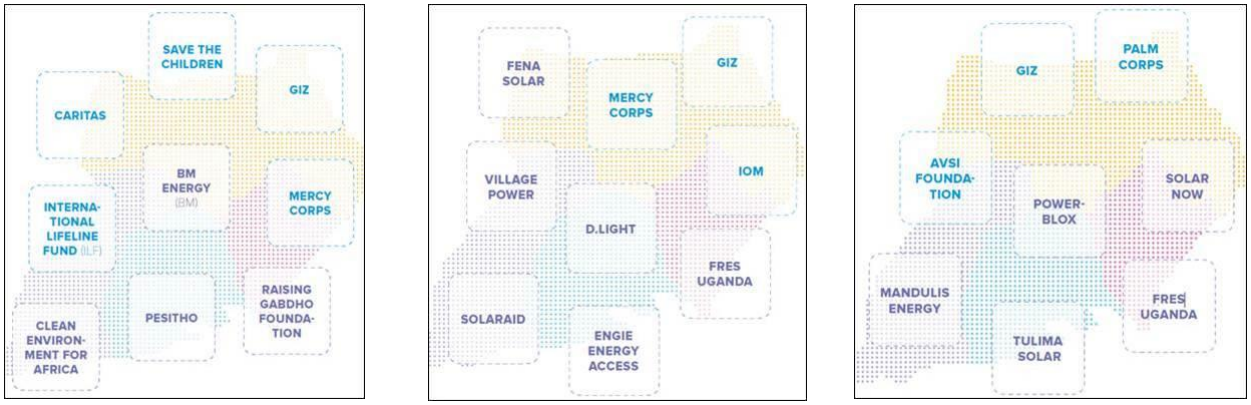

Figure 8: Main stakeholders in Uganda regarding clean cooking (left), electricity (middle) and Businesses & community facilities (right), caption: Blue – Humanitarian and development actors, Purple – private companies, [8]

As the multitude of actors is much broader than this overview, another insightful source are the Response Innovation Labs, which developed a relevant actor clustering (Figure

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9) [12]. Further information can be found, and their resources be accessed under the links in the section of Further literature.

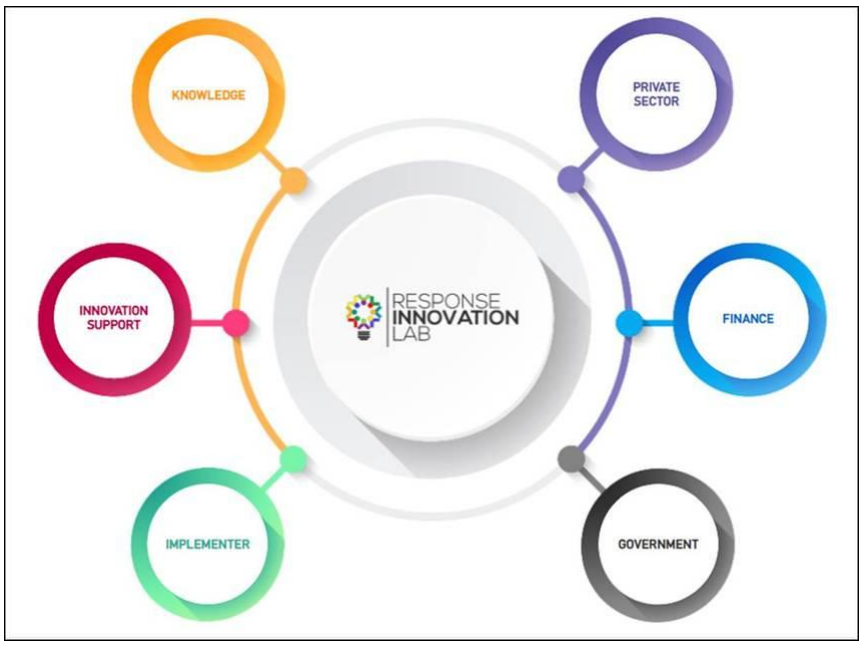

Figure 9: Ecosystem mapping clustering actors by Response Innovation Lab, [12]

3.1.3. Introduction to the Bidibidi Settlement

One of the two project demonstration sites is the Bidibidi refugee settlement, located in Yumbe District in northwestern Uganda. According to UNHCR data from August 2025, the settlement hosts 208,720 individuals in 36,831 households, making it one of the largest refugee settlements in the country [15]. Bidibidi was established in September 2016 in response to a large-scale influx of refugees from South Sudan, primarily from the Greater Equatoria region. Within a few months, the settlement experienced a rapid population increase, exceeding 280,000 individuals, and became one of the largest refugee settlements globally. By December 2016, the settlement had reached its maximum carrying capacity, and new arrivals were temporarily restricted [13]. Bidibidi is divided into five zones (Figure 11Figure 11: Map of the Bidibidi settlement with its five zones and classification of land use [9]).

Demography

The population in Bidibidi is predominantly South Sudanese (208,565 individuals), followed by Sudanese (108), DR Congo (41), and Ethiopian (3) nationals . 52% of the population are female, 28% are youth between 15 and 24 years of age, and 3% are elderly (over the age of 60 years). According to data from August in 2025, 9,852 women and 5,407 men living in Bidibidi have specific needs, such as a serious medical condition or disability, are a woman or older person at risk, or a single parent [15].

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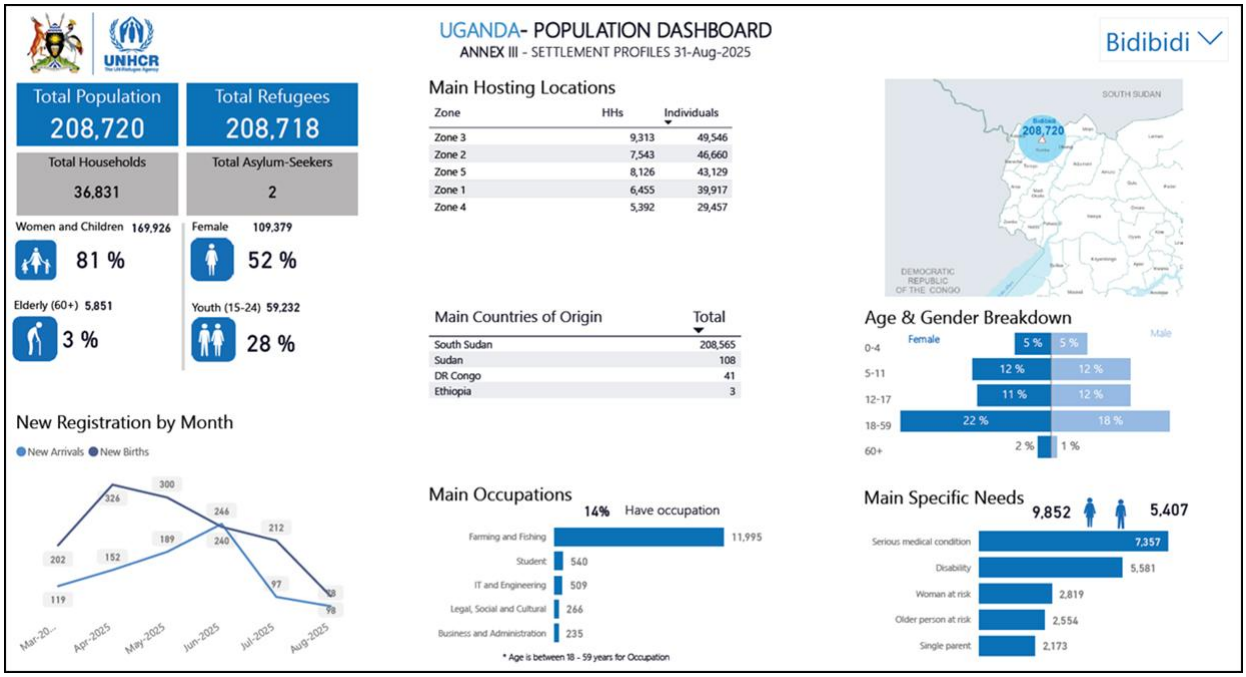

Figure 10: Population dashboard statistics of Bidibidi settlement by UNHCR in August 2025, [15]

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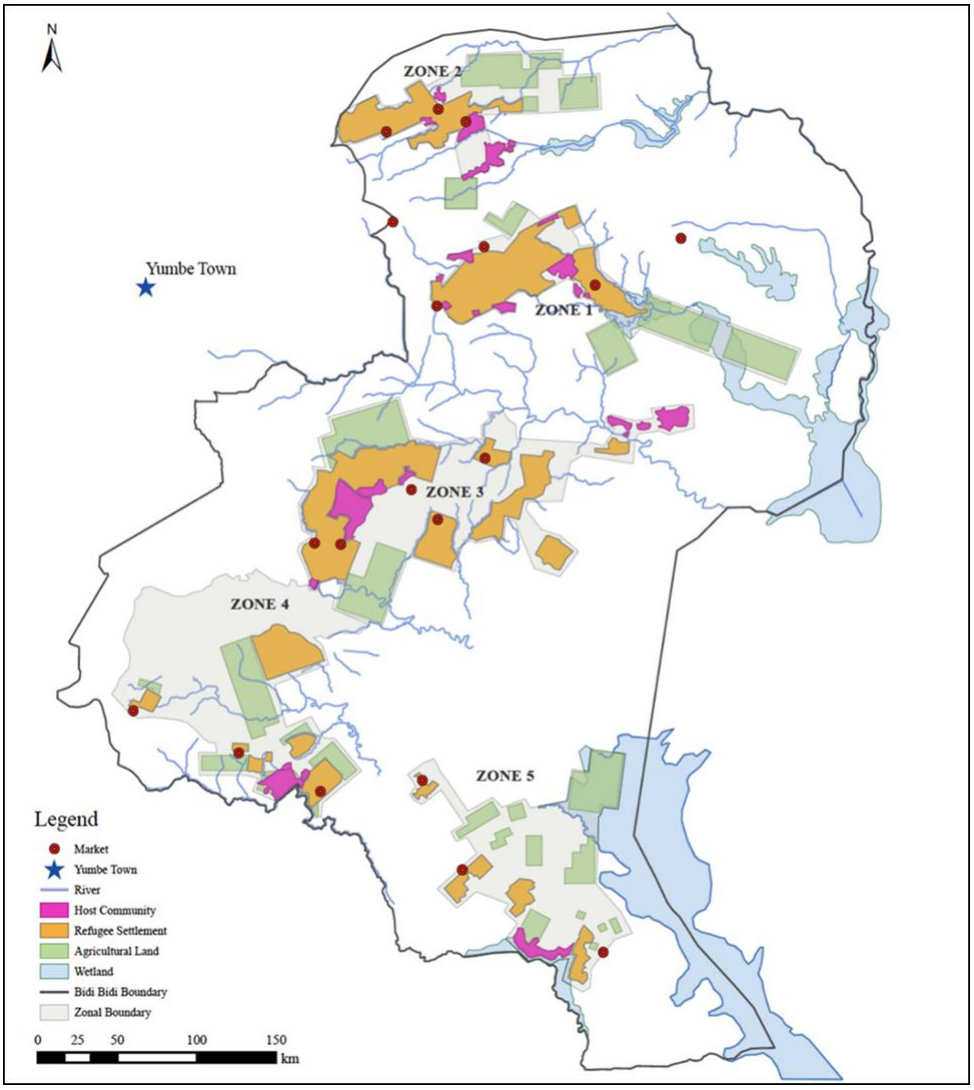

Figure 11: Map of the Bidibidi settlement with its five zones and classification of land use [9]

Housing, Land, and Property (HLP) Access

Bidibidi is divided into five zones (Figure 8). No households surveyed by UNHCR (2019) reported formal ownership or legal tenure of their shelters. While nearly all households (99%) have self-constructed shelters, access to materials, financial resources, and technical support remains limited, restricting maintenance and repair. Over half of households surveyed by UNGCR in 2019 (54%) reported structural damage, and 50% expressed concerns about eviction and personal safety [13]. Land for housing and cultivation is largely informal. 80% of surveyed households reported using their shelter plot for cultivation. Of households that had access to agricultural land, 91% gained free access to the land through the Office of the Prime Minister (OPM), 6% gained free access otherwise, and only 2% owned the land. Formal tenure documentation is rare, as only half of those using rented or borrowed land have formal agreements [13].

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Community Relations and Conflicts

Relations in Bidibidi are generally positive. Nevertheless, tensions persist over land, natural resources, and aid distribution. Refugees rely on cooperation with the host community for access to resources, while the host community benefits from development initiatives and aid programs. Leadership structures remain male-dominated, despite a majority female population, contributing to gender-related conflicts. Environmental pressures, such as firewood collection, exacerbate disputes and pose safety risks for women. Additional sources of tension include biometric verification procedures and fluctuating food rations. Weak legal awareness among refugees and incomplete land tenure systems hinders conflict resolution. While formal dialogue mechanisms help reduce tensions, sustainable stability requires inclusive governance, practical cooperation, and responsible resource management [16].

3.2. Rwanda

3.2.1. Introduction to Rwanda

Rwanda is a landlocked country in East Africa, located in the Great Lakes Region. It borders Uganda to the north, Tanzania to the East, Burundi to the South, and the Democratic Republic of the Congo to the West (Figure 12). Covering an area of over 26,000 km², Rwanda lies just South of the Equator. Its capital and largest city is Kigali, situated at 1,567 m in the country's central plateau. Rwanda is known as the "Land of a Thousand Hills" due to its predominantly mountainous terrain and high elevations. Most of the country consists of plateaus ranging from 1,500 to 2,000 m, descending to less than 1,500 m toward the east. The landscape features mountain ranges in the west, savannas in the southeast, and numerous rivers and lakes. Volcanoes in the northwest rise above 2,000 m, reflecting the country's position at the convergence of the African Great Lakes and Southeast Africa regions [17], [18], [19].

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Figure 12: Map of the Republic of Rwanda, [19]

Rwanda is a presidential republic. Its chief of state is President Paul Kagame (since 2000), and the head of government is Prime Minister Justin Nsengiyumva (since July 2025). The legislature consists of a bicameral Parliament, comprising the Senate (upper house) and the Chamber of Deputies (lower house). Historically, Rwanda emerged from the Kingdom of Rwanda and gained independence from Belgium on 1 July 1961. The official languages spoken are Kinyarwanda, French, English and Kiswahili [17], [18].

Climate

Rwanda has a tropical highland climate, characterized by two rainy seasons (March–May and September–December) and two dry seasons each year [18, 19, 20]. Although located within the tropics, its high elevation moderates temperatures, resulting in a temperate climate. A regional classification according to Köppen–Geiger is provided in Figure 13.

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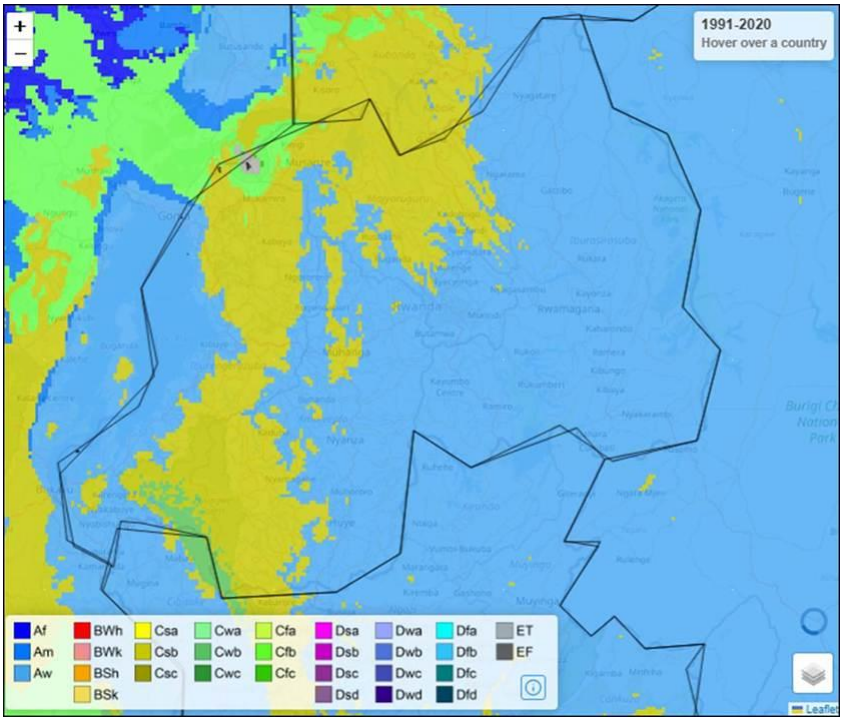

Figure 13: Köppen-Geiger climate classification of Rwanda, Aw = Tropical savanna climate, Csb = Warm-summer Mediterranean climate, Cwb = Subtropical highland climates with monsoon influence, Cfb = Subtropical highland climates with uniform rainfall, [4]

Average temperatures across Rwanda are around 20°C, varying with altitude. The eastern lowlands and Bugarama Valley are the warmest, with annual averages reaching up to 24°C. The central plateau experiences slightly cooler temperatures of 17–19°C, while the highlands can be colder than 17°C. Temperatures remain relatively stable year-round due to Rwanda's equatorial location and elevated terrain [18, 19, 20].
Rainfall patterns are influenced by the seasonal passage of the Intertropical Convergence Zone (ITCZ). Precipitation peaks during the two rainy seasons, with the highest rainfall in the mountainous west, while the eastern regions remain comparatively dry (Figure 14) [18, 19, 20].

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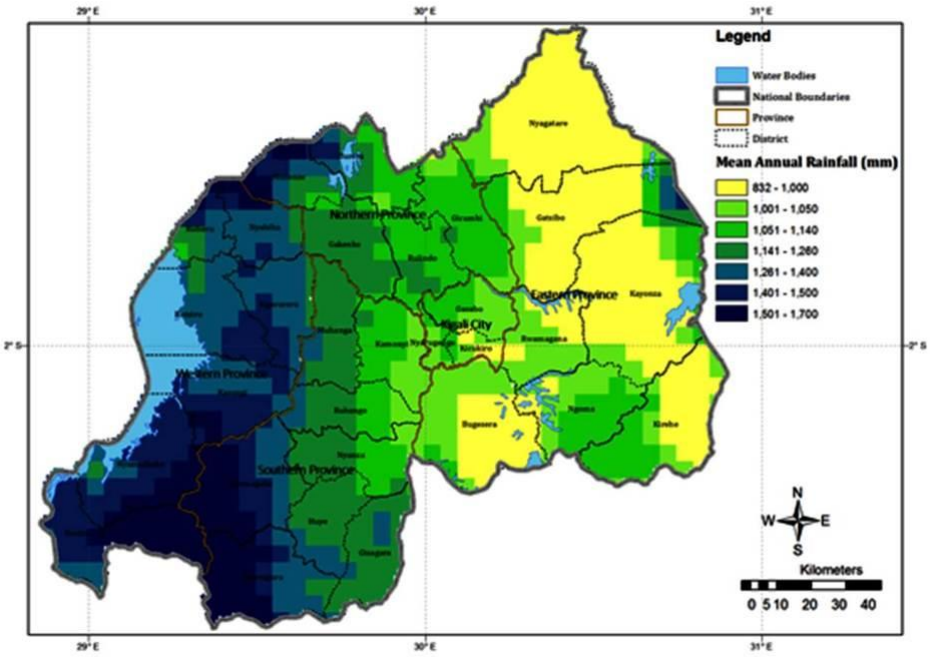

Figure 14: Precipitation map of Rwanda, Rwanda Meteorology Agency, https://www.meteorwanda.gov.rw/index.php?id=30&L=1

Population

As of 2024, Rwanda's population was estimated at 13.6 million, with an annual growth rate of 1.62%. With around 520 inhabitants per square kilometre, it is among the most densely populated countries in Africa. 82% of the population live in rural areas, whereas 18% live in urban areas. The capital, Kigali, is the largest urban centre. Christianity is the dominant religion, while smaller segments of the population identify as Muslim, non-religious, or adherents of other faiths. The population pyramid (Figure 15) reflects a predominantly young demographic structure, though a narrowing base indicates a stabilising or declining fertility rate. A noticeable contraction is also observed among the 30–40 age cohorts. Across most age groups, women slightly outnumber men—a pattern likely linked to the demographic impacts of past conflicts [17], [18].

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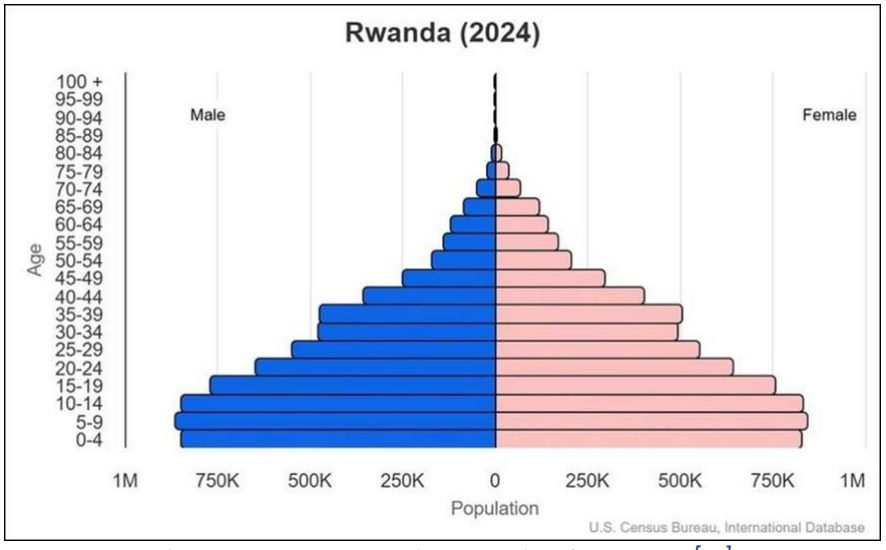

Figure 15: Demographic pyramid of Rwanda, [17]

Economy

Rwanda's economy is predominantly agrarian, with agriculture forming the backbone of national output and employment. Key industrial sectors include cement, agricultural products, small-scale beverages, soap, furniture, shoes, plastic goods, textiles, and cigarettes. Major export commodities comprise gold, tin ores, coffee, malt extract, and rare earth ores. The national currency is the Rwandan franc (RWF) [17], [18].

In 2024, Rwanda's nominal GDP was estimated at USD 14.252 billion and USD 46.543 billion in purchasing power parity (PPP) terms [17]. This corresponds to a per capita GDP of approximately USD 1,040 nominally and USD 3,400 in PPP terms [17]. In the same year, the economy grew by 8.5%, with an average growth rate of around 7.1% projected for the coming years [21]. Rwanda records a medium level of income inequality, reflected in a Gini index of 43.7, and a medium level of human development, with an HDI of 0.578 [5].

3.2.2. Introduction to the displacement context in Rwanda

Because of several conflicts in the region, especially in recent history, the country hosts a considerable refugee population. This section provides a brief overview of Rwanda's displacement context, drawing on A Roadmap for Energy Access in Displacement Settings: Rwanda [22] (2023) and READS Summary: Kenya, Rwanda, Uganda [8] (2024), which offer detailed analyses of local conditions

As of 2023, Rwanda hosted approximately 134,000 people of concern, of which 61% are refugees originating mainly from the Democratic Republic of the Congo (82,000 people) and 38% originating from Burundi (50,000 people) [22, 8].

The refugee population is notably young, with nearly half under 18 years old, while only 4% are aged over 60. Refugee camps are distributed across the country, with many located near the borders with the DRC and Burundi—such as Mugombwa, Kigeme, Kiziba, and Nkamira (Figure 16). Others, including Nyabiheke and sites in Kigali, are situated further inland. The largest camp by far is Mahama, one of the SUNNY project's

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demonstration sites, hosting nearly 60,000 refugees (around 45% of Rwanda's total refugee population).

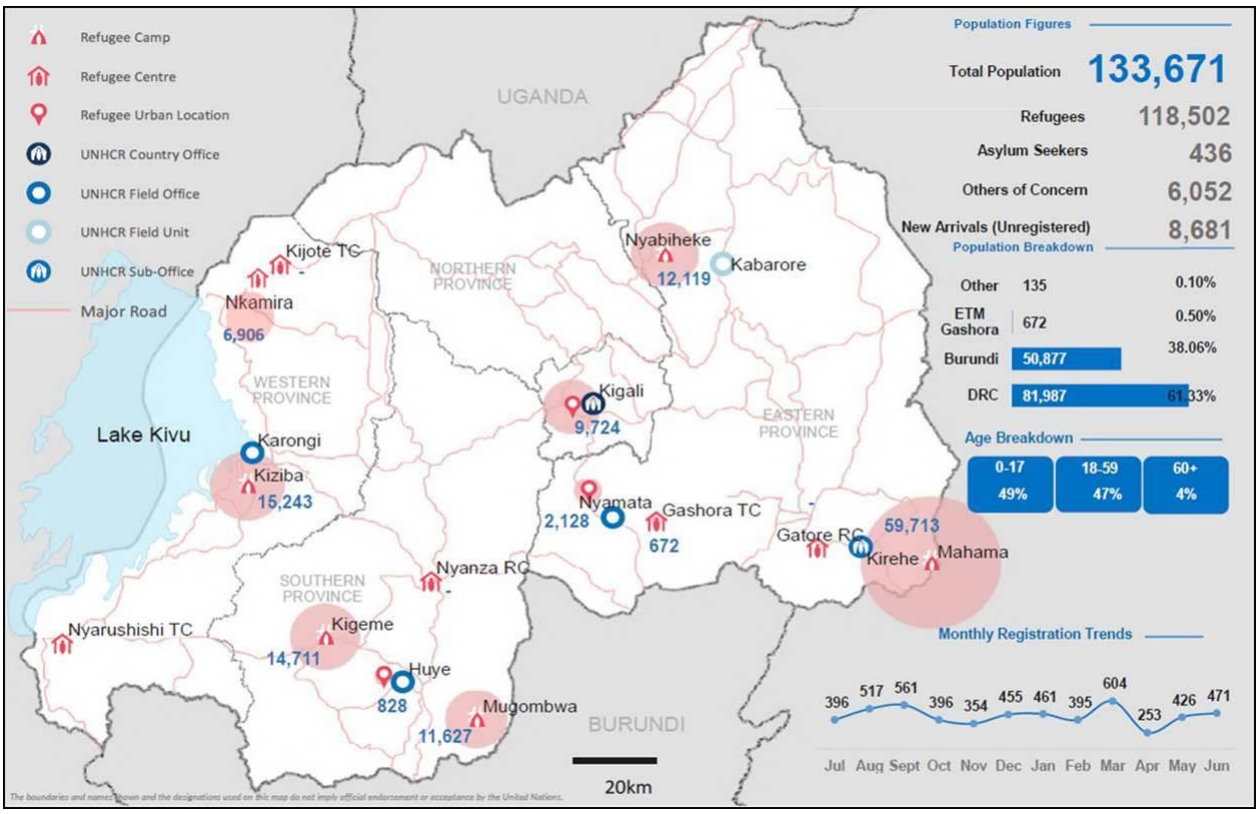

Figure 16: Map of Rwanda with the locations of refugee camps and other UNHCR sites, and a breakdown of the population of concern as of 30 June 2023, [22]

While the distribution of displaced persons across Rwanda is relatively balanced, the size of host communities varies considerably. Mahama camp remains the largest, followed by Kiziba, Kigeme, Nyabiheke, and Mugombwa, each accommodating more than 10,000 people. Smaller groups are present in Kigali, Nyamata, and Nkamira (a transit centre), while fewer than 1,000 individuals are hosted in urban Huye and other minor locations [22, 8].

The Rwandan government has opted for a more concentrated approach to hosting the populations of concern, establishing camps, centres, and urban locations for this purpose. While this strategy offers several operational and logistical advantages, it also presents challenges that require careful management. In October 2018, the Rwandan government introduced a ban on the use of firewood in refugee camps, following concerns over excessive wood consumption and consequent deforestation in surrounding areas. This policy shift necessitated the search for alternative cooking energy solutions. In response, the United Nations High Commissioner for Refugees (UNHCR) began sourcing alternative fuels—primarily briquettes and pellets—from the Rwandan energy market to supply most refugee-hosting sites. For the large-scale

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Mahama camp, a transition towards liquefied petroleum gas (LPG) is currently being pursued [23].

Most relevant organizations

Rwanda's stakeholder landscape in the humanitarian energy and development sectors is diverse, comprising three main groups: humanitarian and development organizations, private enterprises, and financial institutions. According to the READS Summary Report [8], these actors are primarily engaged across three thematic areas clean cooking, electricity, and business and community facilities (Figure 17).

Among the humanitarian stakeholders, Practical Action is a key player active across all three thematic areas and serves as the principal stakeholder in energy access, particularly in clean cooking and electrification. In the field of business and community facility development, Alight and Energy 4 Impact also play significant roles. The main financial institution supporting these initiatives is Inkomoko.

The private sector in Rwanda is dynamic and expanding. In the clean cooking segment, active companies include Urumuri, Bamboo, Ecogreen Solutions, Oak Investments, and BioMassters. OffGridBox operates in both the electricity and community facility domains, while Belecom and Bboxx focus primarily on electrification. In business and community facility development, MeshPower and Solektra are notable contributors.

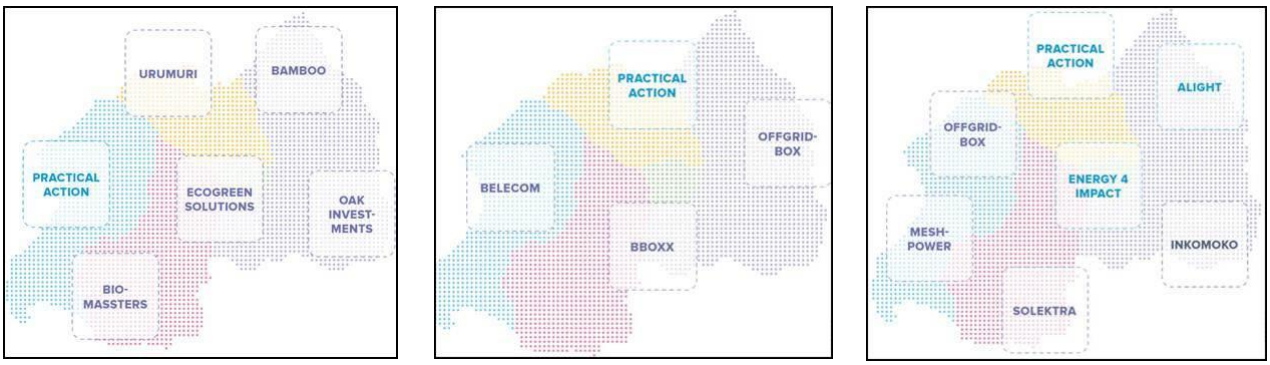

Figure 17: Main stakeholders in Rwanda regarding clean cooking (left), electricity (middle) and Businesses & community facilities (right), caption: Blue – Humanitarian and development actors, Purple – private companies, black – finance institutions ,[8]

3.2.3. Introduction to the Mahama camp

The second demonstration site of the SUNNY project is the Mahama Refugee Camp, located in the Kirehe District of Rwanda's Eastern Province (Figure 18), at two kilometres from the border to Tanzania. Established in 2015 as part of the national strategy to provide protection and humanitarian assistance to displaced persons. The camp covers an area of approximately 160 hectares designated for its establishment and operation

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[23, 24]. The camp is structured into 18 villages and 9 quartiers. A total of 33 humanitarian organizations were active in the camp as of 2023 [24].

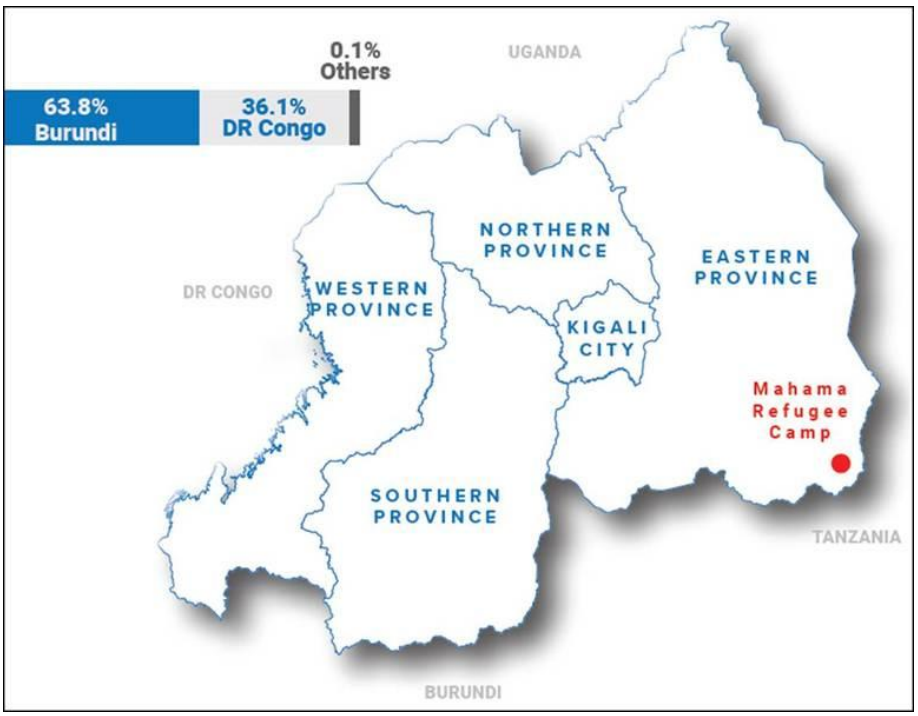

Figure 18: Location of Mahama Refugee Camp in Rwanda & satellite view of Mahama camp, [24]

Demography

As of the latest UNHCR demographic assessments, Mahama Refugee Camp accommodates over 60,000 individuals living in approximately 17,000 households. The majority of inhabitants (63%) originate from Burundi, primarily the Kirundo region, while 36.1% are from the Democratic Republic of the Congo, almost exclusively from North Kivu. Only 0.1% of residents come from other countries. However, among the new arrivals to Mahama in the first five months of 2025, the largest share originates from Sudan and other nationalities (see Figure 19). The population of Mahama includes 54,674 registered refugees, 5,671 asylum seekers, and 3,047 individuals categorized as "Others of Concern", a group comprising children born to refugee and Rwandan parents (see Table 3). The camp's demographic profile is notably young, with about 51% of residents under the age of 18. Women represent roughly 50% of the total population. All refugees aged 16 years and above are issued official state identity cards [23], [24], [25].

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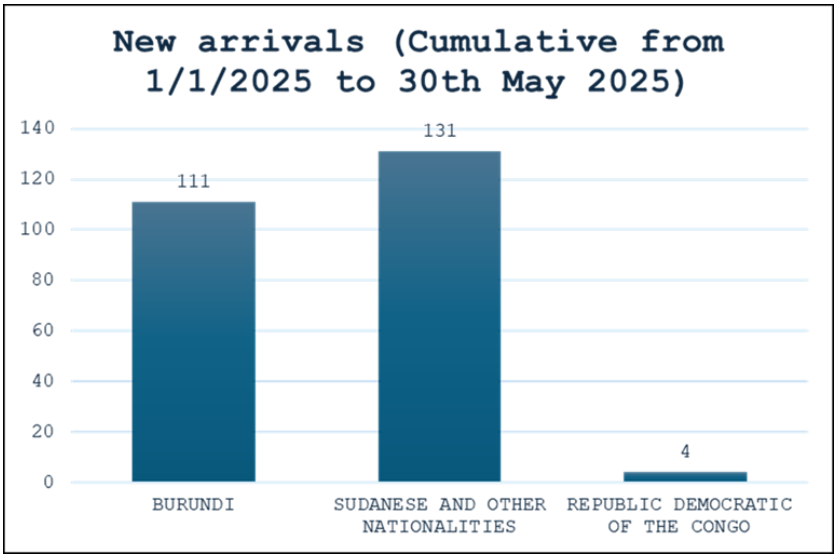

Figure 19: New arrivals to Mahama Camp cumulative in 2025 until 30th May, [25]

Table 3: Camp population distribution by gender, age, nationality and asylum seeker status, [25]

Refugee Status	**Population by Nationality**
68,664 individuals (18,140 households) Females: 34,738 (50.1%) Males: 33,907 (49.1%) Adults (43.6%); Children (50.6%) Unaccompanied or separated children (UASC): 445 (187f, 258m) - (0.3%) Elderly (3.5%)	Congolese: 26,647 Burundians: 41,833 Other Nationalities: 166
Asylum seekers status (pending the determination of refugee application) 1,302 asylum seekers (from 613 households)	

Education and Livelihoods

Educational levels remain low among the population in Mahama. 36% of residents have received no formal education, 40% completed primary education, 22% attained secondary education, and only 2% hold a university degree. The predominant livelihoods within the camp include small-scale trade, agriculture, forestry, and fishing. Approximately 8% of the population have been identified as persons with specific needs

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[23], [24], [25].

Administration

UNHCR [23] provides an overview about the administrative structures of the camp. The camp is administered by the Ministry in Charge of Emergency Management (MINEMA) in collaboration with the United Nations High Commissioner for Refugees (UNHCR). Together, they oversee protection, security, and service provision through regular coordination meetings and multifunctional monitoring. The settlement is divided into two sites—Mahama I and Mahama II—comprising 18 villages. On-site management is led by a Camp Manager and Deputy Camp Manager from MINEMA, supported by the Directorate General of Immigration and Emigration (DGIE) and the Rwanda National Police (RNP). A refugee leadership structure complements formal governance, including eight executive committee members, nine quarter leaders, and 18 village leaders.

Support of refugee self-reliance

UNHCR is actively supporting the capacity of residents in Mahama for improved self-reliance. In collaboration with Caritas Rwanda and with financial support from the Government of Denmark, implemented a program to enhance entrepreneurship and employment among refugees and host community members in the Mahama refugee camp. Between 2022 and 2023, the initiative provided start-up grants to 669 refugees and 287 host community members, enabling the establishment of micro- and small-scale enterprises. The programme seeks to foster self-reliance, economic inclusion, and sustainable livelihoods within the camp and its surrounding areas. In 2024, UNHCR and Caritas Rwanda expanded their support through structured coaching and mentorship activities, enhancing business management and operational skills among beneficiaries. Additionally, 944 participants took part in refresher training sessions on financial literacy and the Savings and Internal Lending Community (SILC) methodology between January and March 2024. Collectively, these interventions demonstrate a strong commitment to building the socio-economic resilience of both refugee and host populations through entrepreneurial development and financial education [23].

Stakeholders

The humanitarian and development response in Mahama Refugee Camp involves a diverse and coordinated stakeholder environment, encompassing implementation partners, operational partners, and other UN agencies [23].

Seven specialized organizations lead the delivery of core services as implementation partners of UNHCR, each aligned with its technical expertise and mandate. MINEMA oversees overall camp management and coordination, ensuring compliance with

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national policies. Save the Children International (SCI) provides health, nutrition, child protection, and sexual- and gender-based violence (GBV) prevention and response services. ADRA manages logistics, facilitating the timely distribution of relief supplies. Caritas Rwanda implements livelihood programs to promote economic resilience and self-reliance. Prison Fellowship Rwanda (PFR) delivers community-based protection and legal assistance. World Vision International (WVI) oversees education, water, sanitation, hygiene (WASH), and environmental conservation activities. Humanity & Inclusion (HI) supports persons with specific needs, ensuring accessibility and inclusive services for individuals with disabilities [23].

Livelihood-focused initiatives are supported by a network of operational partners, including Inkomoko, Alight, Maison Shalom, Rwanda Red Cross, Pro-Femmes/Twese Hamwe, Indego Africa, GIZ, Practical Action, and Umutanguha Microfinance. These organizations provide specialized expertise in entrepreneurship training, financial access, social inclusion, and sustainable development, collectively enhancing self-reliance and income-generation opportunities for camp residents [23].

Several other UN agencies complement UNHCR's efforts, ensuring integrated support across key humanitarian sectors. WFP leads food distribution and cash-based assistance, UNICEF provides education and child protection services, UNFPA delivers reproductive health and maternal care programs, and the International Organization for Migration (IOM) manages resettlement logistics, including sanitation, transport, and medical screening. Together, these agencies form a coordinated framework addressing nutritional, educational, health, and mobility needs through multi-sectoral interventions [23].

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4. State of access to energy

This section provides a comprehensive overview of energy access, focusing on its relevance to displaced populations and the project's demonstration sites in Uganda and Rwanda. It begins with a global perspective, narrows to Africa, and then examines the specific contexts of displacement locations, ensuring a holistic understanding of local and regional energy challenges.

4.1. State of access to energy globally

Relevance of access to energy globally

Energy access is a critical driver of economic development, social equity, and human wellbeing. It encompasses the ability of individuals, households, and communities to secure reliable, affordable, and modern energy services for lighting, heating, cooking, communication, and productive activities. Significant disparities persist, particularly among rural and marginalized populations, limiting educational, health, and economic opportunities.

According to the Energy Progress Report [1], global energy access progress remains insufficient: In 2030 approximately 645 million people will lack electricity, and 1.8 billion will rely on unsafe and polluting cooking fuels projections estimate. Renewable energy accounted for 30% of electricity consumption in 2022, yet progress in transport sector integration remains limited. Global renewable energy share in total final energy consumption increased from 15.6% in 2015 to 17.9% in 2022, indicating steady but insufficient advancement toward clean energy transition [1].

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Sustainable development goals and energy access

Apart from the direct link of energy access and SDG 7, energy access contributes directly to multiple SDGs. Electricity, clean cooking, and sustainable transport solutions collectively advance social, economic, and environmental outcomes [2], [3]. The relationship between energy access and the SDGs is heavily dependent on the applied methodological framework.

Understanding energy access requires evaluating electricity generation, clean cooking technologies, and renewable energy deployment. These insights are essential for policy design and strategic interventions aimed at achieving Sustainable Development Goal 7 (SDG7), which targets universal access to affordable, reliable, sustainable, and modern energy by 2030 [1], [2], [3].

International support for clean and renewable energy in the Global South is on the rising, having increased to 21.6 billion USD in 2023, and marking a 27 percent rise from the previous year and the third consecutive annual increase. Despite this improvement, current investment flows represent only about three-quarters of the 2016 peak level of 28.4 billion USD, underscoring the persistent gap between existing funding and the scale of investment required to meet global energy sustainability targets [1], [4].

Global Inequalities in Energy Access

Energy access remains highly uneven worldwide. Global electrification rose from 84% in 2010 to 92% in 2023, yet approximately 2.1 billion people lack clean cooking solutions, while 666 million live without electricity [1], [3]. Sub-Saharan Africa accounts for the majority of these populations, projected to host nine out of ten people globally without electricity by 2030. Access to clean cooking improved from 64% in 2015 to 74% in 2023 globally, but sub-Saharan Africa faces persistent deficits [1], [4]. This underscores the region's central role when addressing the global energy access gap, as demonstrated in Figure 20 and Figure 21[4]. Access strongly correlates with income, with poorer households showing limited electricity and clean cooking [4]. Rural populations face the greatest disparities, underscoring the need for targeted policy interventions [4].

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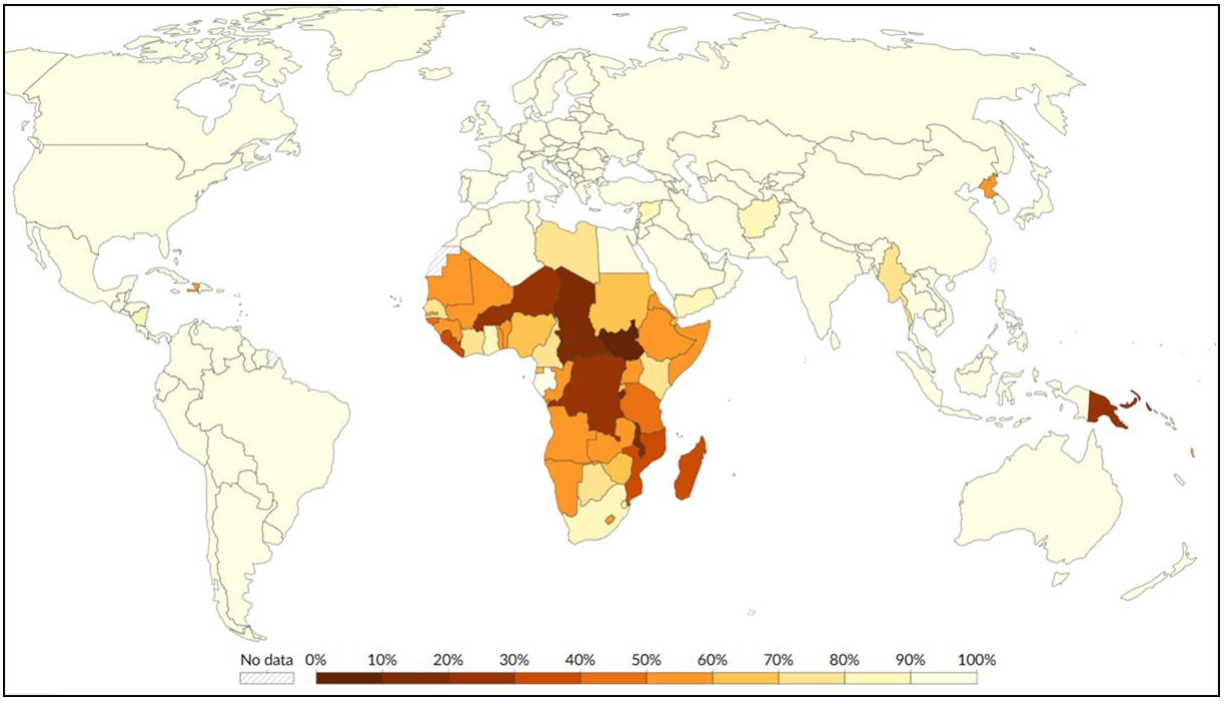

Figure 20: Share of the population with access to electricity, 2023 (Access to electricity is here defined as having a reliable source that supplies sufficient power for basic energy services), [4]

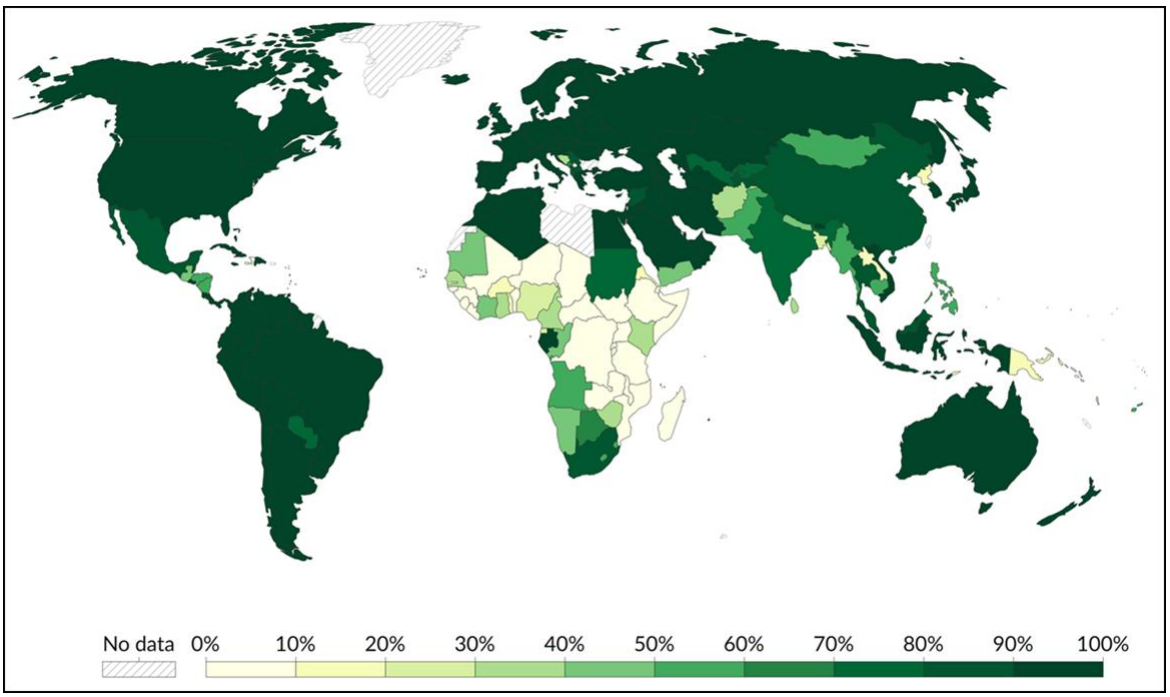

Figure 21: Share of the population with access to clean cooking fuels in 2023 (Clean cooking fuels and technologies here refer to non-solid fuels, including natural gas, ethanol, and electric-based solutions), [4]

Energy Access on the African continent

The African continent faces the most severe energy access challenges globally, with

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rural areas and sub-Saharan Africa experiencing the greatest deficits (Figure 22) [5]. Although access to electricity has improved in recent years, clean cooking remains a far greater concern, contributing to widespread household air pollution and a high incidence of premature deaths, especially among women and girls, who are primarily responsible for domestic cooking activities.

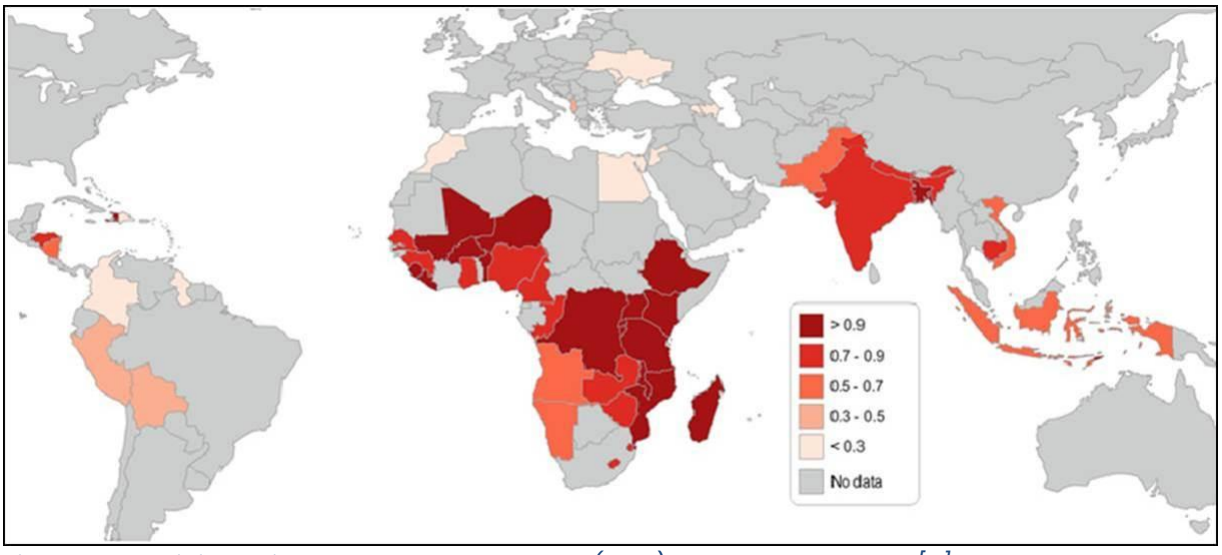

Figure 22: Multidimensional Energy Poverty Index (MEPI) globally by country, [5]

Despite progress in electricity access, the absolute number of people without modern energy services continues to rise (Figure 23).

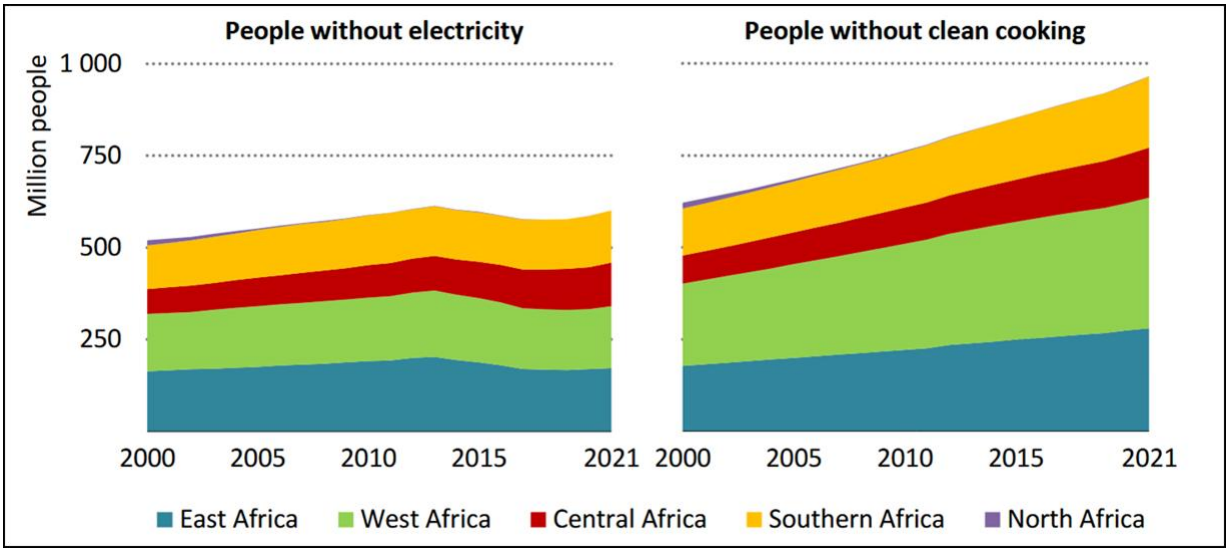

Figure 23: Population without access to modern energy services in Africa [6, p. 35]

As of 2021, around 600 million people in Africa, 43% of the continent's population, remained without electricity, including approximately 590 million in sub-Saharan Africa.

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Between 2019 and 2021, the number of people lacking electricity grew by 4%, reversing earlier progress. Access to clean cooking has deteriorated even more sharply: more than 970 million Africans, nearly three-quarters of the global total without clean cooking, still rely on traditional fuels. From 2010 to 2019, this figure increased by 17 million people annually (about 2% per year), accelerating to 20 million per year during 2020–2021 as the COVID-19 pandemic disrupted projects, reduced investment, and constrained household incomes.

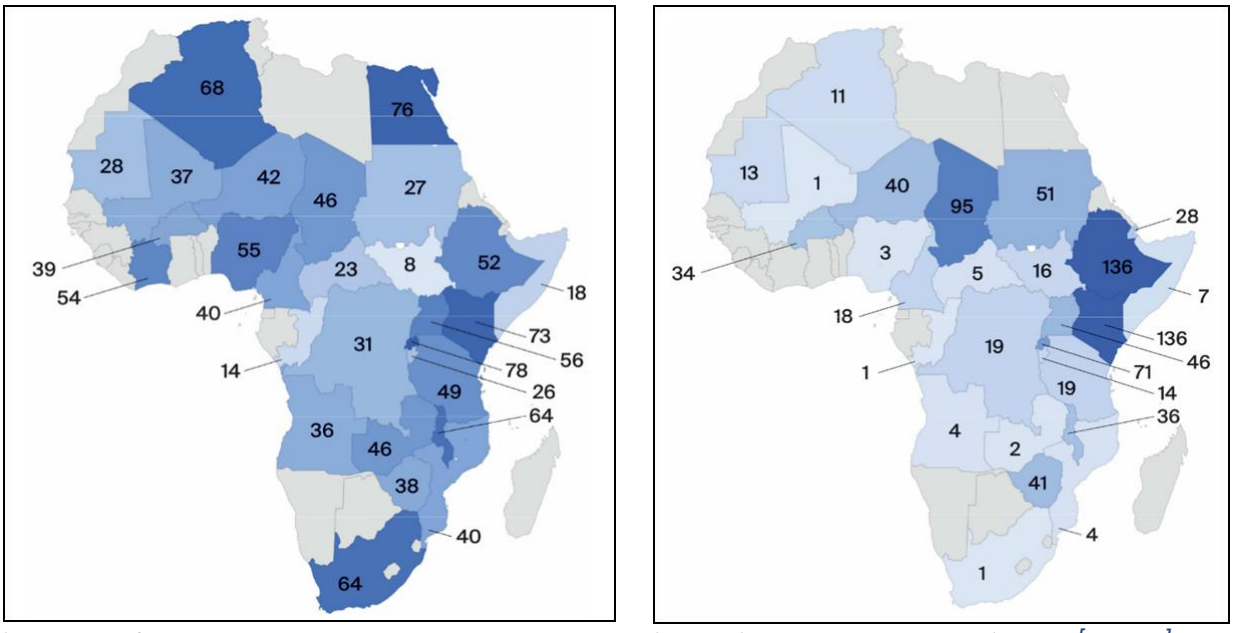

Figure 24: left - RISE overall score on regulatory and policy environment by country in 2021 [7, p. 14] and right - number of energy-related projects in the displacement context per country in 2021 [7, p. 27]

In response, numerous initiatives have been launched to address Africa's growing energy access gap. In 2022, the United Nations High Commissioner for Refugees (UNHCR) mapped ongoing energy programs across the continent [8]. Eastern African countries account for a substantial share of investments targeting improved energy access in refugee-hosting areas [8]. Further details on these contexts are provided in the following chapters.

4.2. State of access to energy in the demonstration countries

Energy access remains a central challenge in both Uganda and Rwanda, where notable progress has been achieved in recent years, but significant gaps persist. The following section provides a brief overview of key trends and progress indicators.

Development of energy access in Uganda and Rwanda

The SDG7 Energy Progress Report [3] and its monitoring tools provide a detailed view of how energy access has evolved globally [3] and, in both countries [9], [10] since the

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early 2000s (Figure 25 and Figure 26).

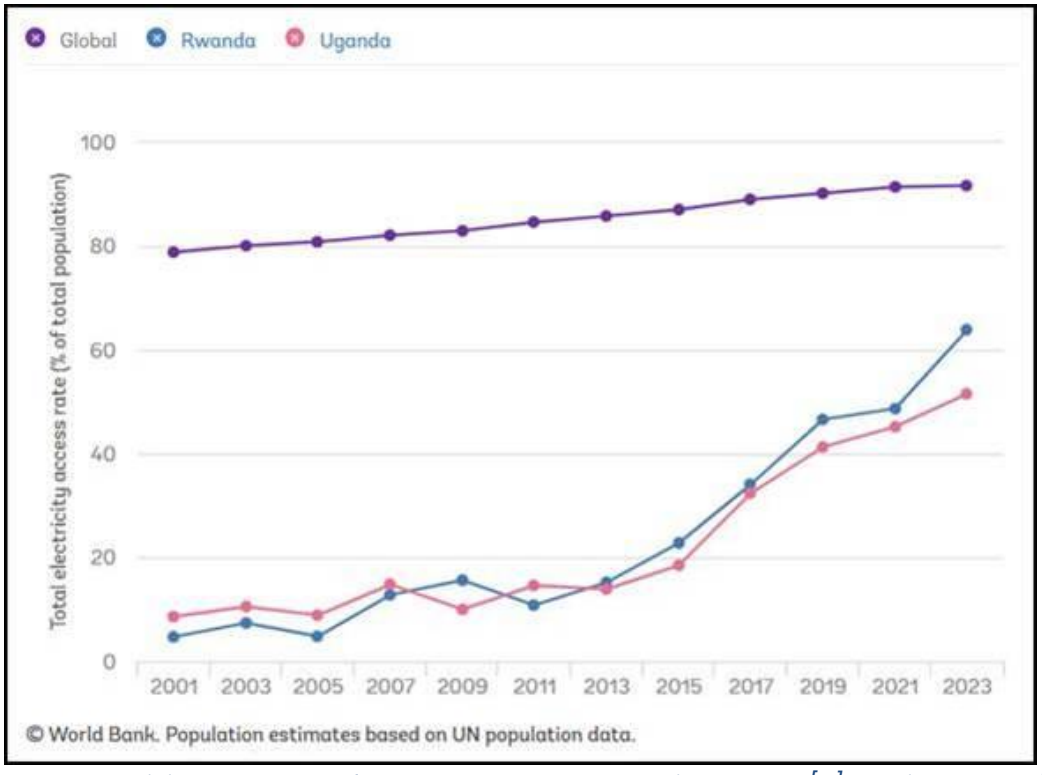

Figure 25: Total electricity access rate from 2001 to 2023 globally, in Rwanda [9] and in Uganda [10] (left), [3]

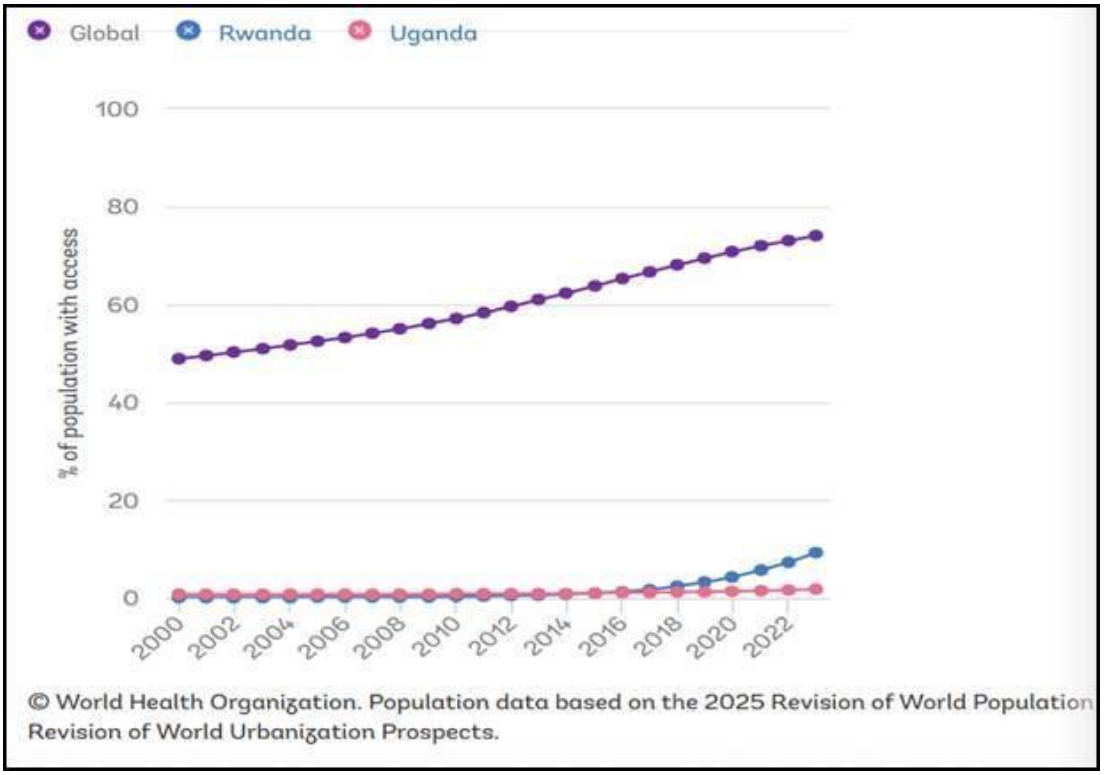

Figure 26: Share of population with access to clean cooking from 2000 to 2023 globally, in Rwanda [9] and

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in Uganda [10] (right), [3]

Since the early 2000s, both countries have experienced sustained growth in electricity access, following similar upward trajectories. However, clean cooking access remains severely limited. Despite global improvements, the majority of households in both countries still rely on traditional biomass for cooking, underscoring a persistent gap between electricity access and the adoption of modern, sustainable cooking solutions [3], [9], [10].

As illustrated in Figure 9, Uganda has achieved significant progress in expanding electricity access since 2000. Over the past decade, the national electrification rate has risen to around 50%, enabling millions of Ugandans to benefit from improved energy services. Nevertheless, approximately half of the population still lacks reliable electricity, particularly in rural areas, underscoring ongoing disparities in energy distribution. By contrast, access to clean cooking solutions remains critically low. Although the share of the population using clean cooking fuels and technologies has more than doubled since 2000, overall access remains minimal. Most Ugandans still depend on traditional biomass and other polluting fuels, reflecting the continuing challenge of achieving universal and sustainable energy access [10].

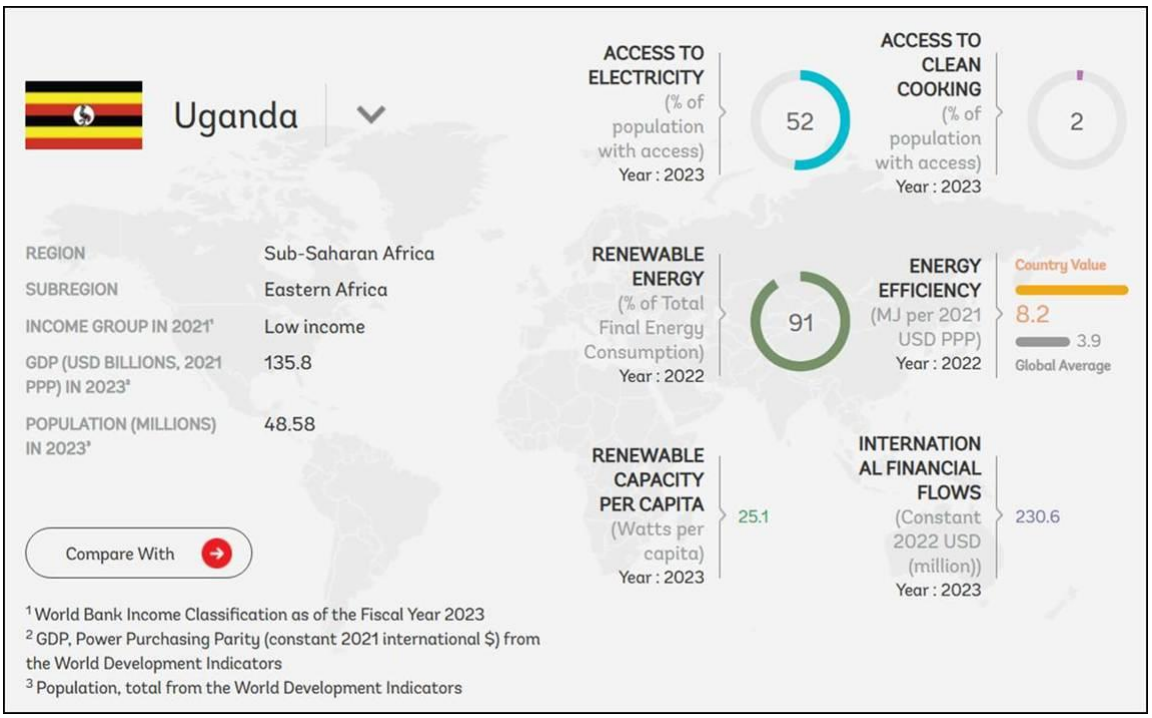

Figure 27: Key indicators of Uganda and it´s energy situation, [10]

The SDG 7 report for Rwanda [9] shows that Rwanda has recorded one of the fastest rates of electrification in Sub-Saharan Africa. Since 2000, and especially after 2015, the

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national electricity access rate has increased dramatically, from just a few percent to over 60% by 2023. This progress reflects substantial investment in both grid extension and decentralized renewable energy systems. Despite these achievements, several million Rwandans remain without electricity, indicating that universal access is yet to be reached.

Progress in clean cooking access has been considerably slower. The share of the population using clean cooking technologies rose from nearly zero in 2000 to about 9% in recent years. While this represents a positive trend, it remains far below the level required for sustainable development. As a result, the vast majority of Rwandans continue to rely on traditional, polluting fuels for daily cooking needs.

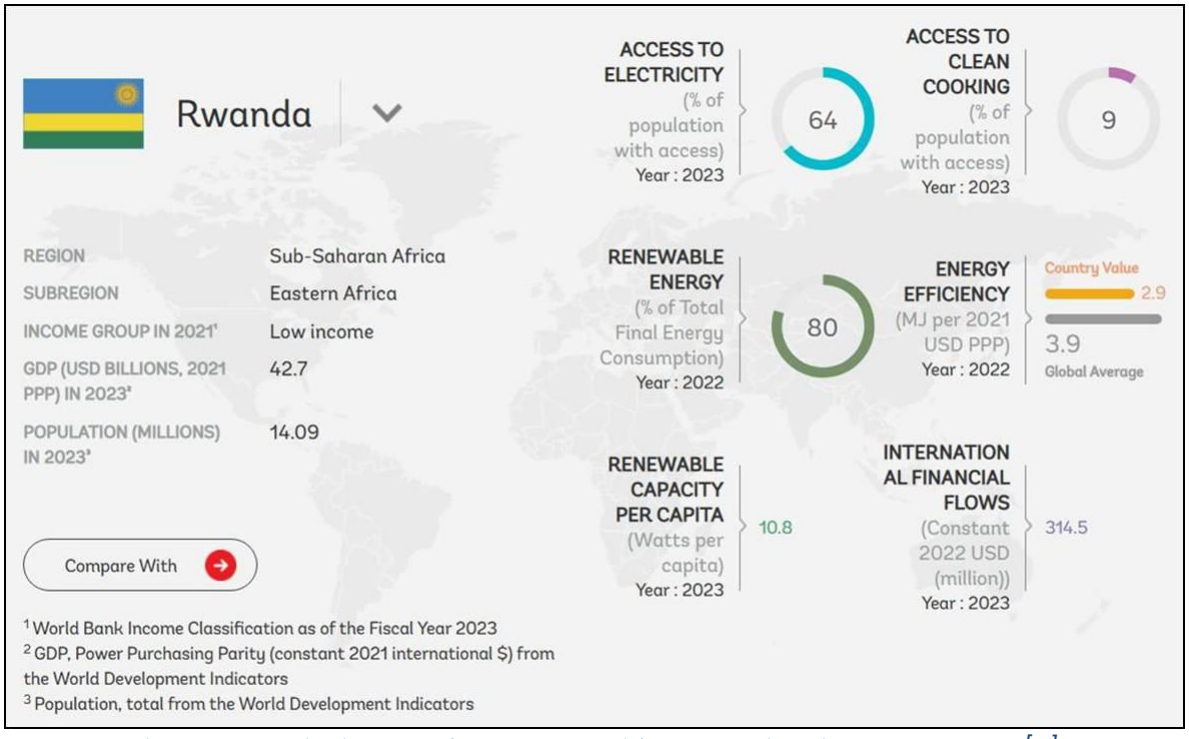

Figure 28: Key indicators of Rwanda and it´s energy situation, SDG7 report, [9]

Energy access indicators

Similar to the global scale, a substantial gap persists between rural and urban areas in terms of access to modern energy services in both Uganda and Rwanda. The following tables summarize energy access performance and disparities in Rwanda and Uganda, based on data from the READS reports, GPA, and the Regulatory Indicators for Sustainable Energy (RISE) framework [11], [12].

The RISE pillars assess countries' policy and regulatory environments across four dimensions: Electricity access, clean cooking, renewable energy, and energy efficiency,

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also giving a general score (Table 4). The RISE assessment identifies both strengths and areas where further development is needed to support universal energy access. These indicators provide insight into national progress toward universal sustainable energy access and identify areas requiring further policy action.

Table 4: RISE Pillar values for Rwanda and Uganda, adapted from [11], [12]

RISE Pillar	Rwanda	Uganda	Sub-Saharan Africa	Global
Overall	71	55	38	61
Electricity access	73	74	51	53
Clean cooking	60	72	35	37
Renewable energy	90	54	43	51
Energy efficiency	62	19	24	48

Both Rwanda and Uganda perform above the sub-Saharan African average across most pillars, reflecting solid policy frameworks and implementation capacity. Rwanda notably exceeds even the global average in overall performance, driven by its strong renewable energy and efficiency policies. Uganda, while trailing Rwanda and the global benchmark, still performs well above regional averages, particularly in electricity and clean cooking indicators.

Rwanda's renewable energy pillar score (90) demonstrates exceptional progress in sustainable generation and grid integration. Conversely, Uganda's energy efficiency score (19) highlights a need for further regulatory and institutional strengthening to reduce energy intensity and enhance end-use efficiency.

In both Uganda and Rwanda, energy access exhibits a pronounced urban–rural divide across examined technologies (Table 5) [11], [12]. Urban areas in both countries demonstrate substantially higher electrification levels, with near-universal access observed in Rwanda and approximately 70% in Uganda. In contrast, rural electrification rates remain comparatively low, ranging between 30% and 40%. Access to clean cooking solutions is markedly limited in both nations. In urban Rwanda, only around 10% of households rely on clean cooking technologies, while in Ugandan cities the rate is approximately 1%, decreasing to well below 1% in rural areas of both countries. These findings highlight the persistent disparities in energy infrastructure development and the critical need for targeted efforts to expand access in rural and peri-urban contexts.

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Table 5: Shares of energy access on electricity and clean cooking in Rwanda and Uganda, adapted [11], [12]

	Electricity		Clean cooking	
	Rural	Urban	Rural	Urban
Rwanda	38%	98%	0.3%	10%
Uganda	33%	70%	0.2%	1%

4.3. Energy Access in Refugee Settlements Uganda

Uganda's national energy policies actively include refugees as part of national development planning. The Energy Policy (2022–2023), Comprehensive Refugee Response Framework (CRRF), and National Development Plan III emphasize refugee inclusion in energy infrastructure and renewable energy initiatives [13].

Flagship national programs—such as the Electricity Access Scale-Up Project (EASP) and the 100% Renewable Energy Roadmap—promote investment and private sector participation in refugee-hosting districts, including Yumbe District, where Bidibidi is located. These initiatives aim to expand access to both electricity and clean cooking solutions [13], [14].

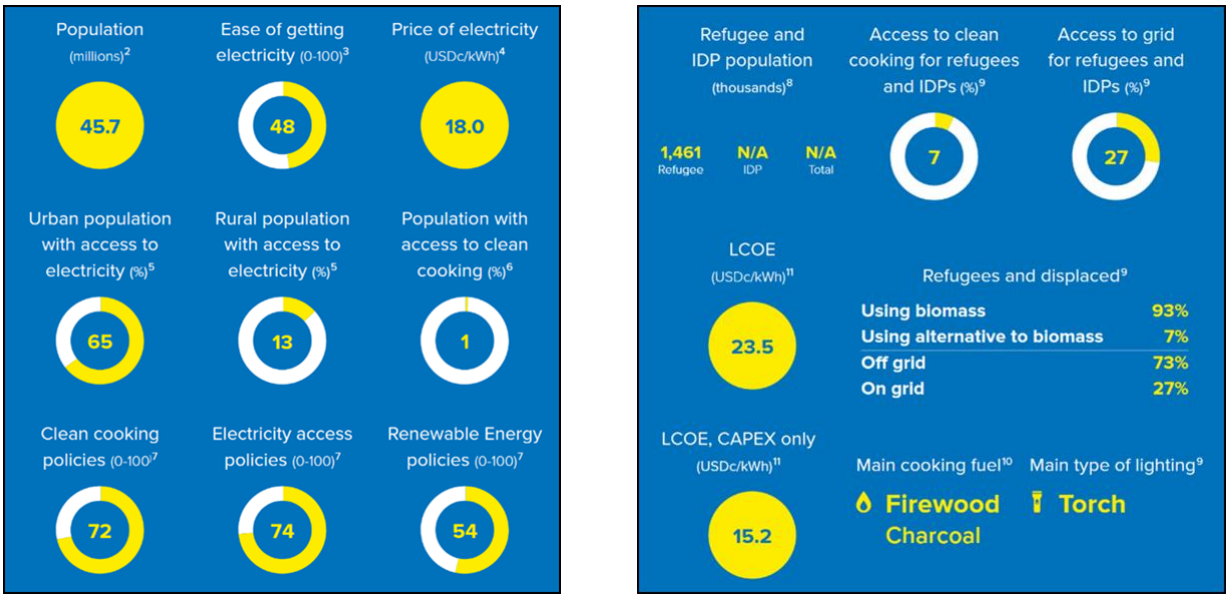

Figure 29: Left - Uganda´s Host Country Energy Outlook (left), [8, p. 25]; Right - Uganda´s Host Country Energy Outlook in the displacement context (right), [8, p. 25]

Lighting

Adequate lighting plays a critical role in areas such as safety, education, and economic activity, while insufficient lighting often hinders daily life.

In 2024 ULEARN published an elaborate study on access to energy covering all refugee

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settlements in Uganda. The study highlights that many communities remain underserved and depend on a variety of different lighting sources. Among these, Pico-PV systems are commonly used, with a prevalence ranging from 20 to 30 percent. Other notable sources include dry-cell torches and solar home systems. In Yumbe District, where Bidibidi settlement is located, dry-cell torches represent the predominant lighting source, used by more than half of the households. Other sources include Tadooba oil lamps, the national electricity grid, candles, and, in some cases, firewood or grass [15].

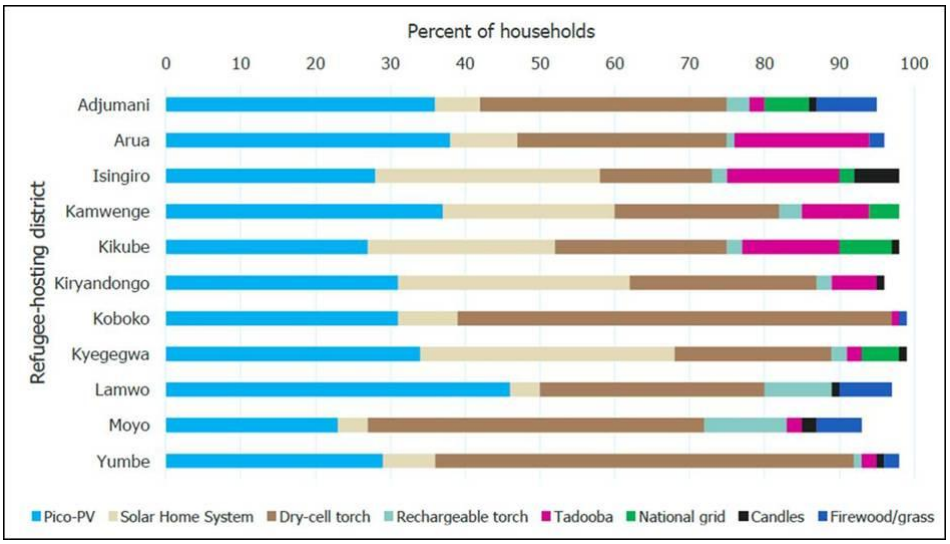

Figure 30: Share of household´s main source of lighting per refugee-hosting district [15]

Electricity

Electricity plays a crucial role for energy access in displacement contexts. Several factors influence the use of solar energy among both refugees and host communities, with similar levels of importance reported across groups.

As part of more elaborate studies, ULEARN studied the motivation for utilizing solar systems for electricity access. The primary motivation is the comparatively lower cost of solar energy compared to other fuels, cited by nearly two-thirds of refugees and about 80 percent of host community members. Environmental considerations are also significant, mentioned by more than one-third of respondents in both groups. Approximately one-quarter of participants report lacking access to the national electricity grid as a reason for adopting solar solutions. Notably, for one-third of refugees, the main motivation stems from receiving the technology free of charge, whereas only about 10 percent of host community members cite this factor. Grid unreliability appears to be a relatively minor reason for adopting solar energy [14].

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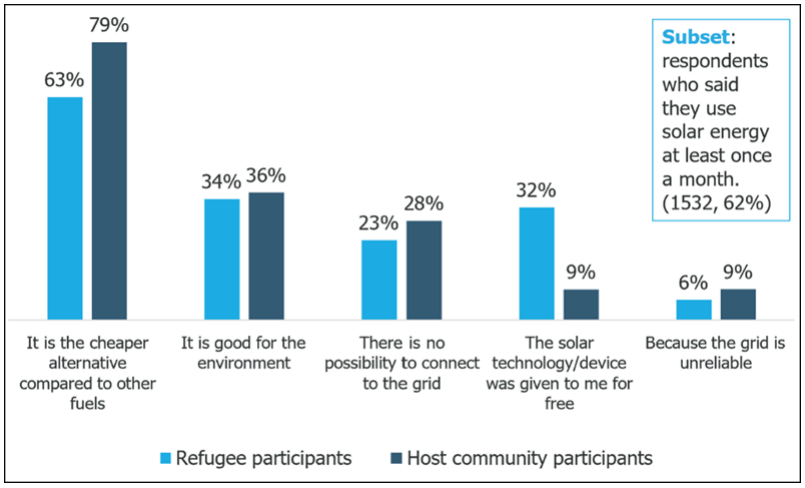

Figure 31: Reasons for solar energy usage in Ugandan refugee and host communities, [14]

Cooking

Cooking plays a crucial role in health, labor efficiency, and environmental sustainability, particularly from a gender equality perspective.

Data from ULEANR shows that traditional cooking methods remain prevalent, with open fires using three-stone stoves and traditional mud or clay stoves being the most common. In the Bidibidi settlement, the traditional mud or clay stove is the dominant type in use. Other stove types, such as improved charcoal stoves, improved mud stoves, improved ceramic stoves, and traditional iron or metal stoves, are used to a much lesser extent. Only slightly more than one-quarter of households in both refugee and host communities possess at least one improved cooking stove, while the majority continue to rely on traditional options [14].

In the Bidibidi settlement, it is reported that more than half of the households surveyed have access to an improved cooking stove [16].

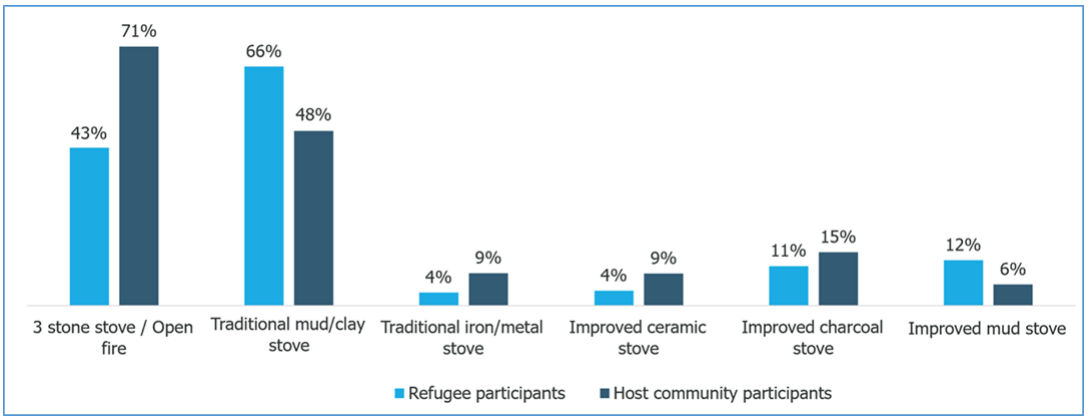

Figure 32: Kinds of stove ownership in Ugandan refugee settlements [14]

The predominance of traditional cooking technologies leads to reliance on low-tech and easily accessible cooking fuels. The vast majority of households in both refugee and host

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communities use firewood, contributing significantly to local tree cutting and deforestation. More than half of these households also use charcoal, making it the second most common cooking fuel. In contrast, briquettes and bio-waste remain marginal energy sources in cooking practices within Ugandan displacement settings. Firewood stands out as the primary cooking fuel across most refugee settlements in Uganda, including Bidibidi, where it serves as the main source for approximately 90 percent of households [14], [15].

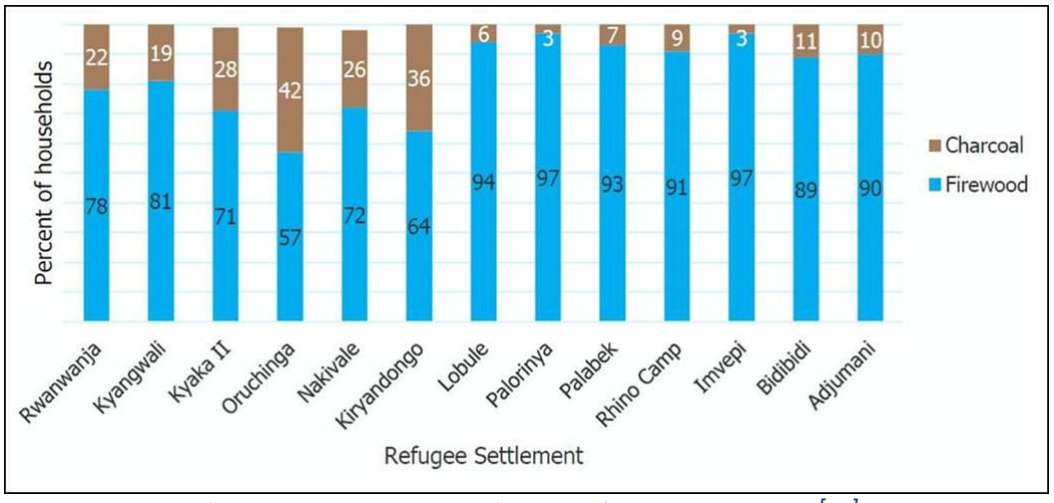

Figure 33: Fuel consumption by refugee settlement, [15]

4.4. Energy Access in Refugee Camps in Rwanda

Rwanda's National Strategy for Transformation (NST1, 2017–2024) and Energy Strategy (2019–2024) have guided grid expansion and off-grid electrification, extending to humanitarian settings [20]. By 2021, about 58% of refugee households in camps had electricity access and 33% used improved cooking solutions [20]. The government's Strategic Plan for Refugee Inclusion (2019–2024), aligned with UNHCR Rwanda's Energy and Environment Strategy (2019–2023), seeks to achieve universal electricity access through grid and off-grid solutions by 2023 [20]. However, persistent challenges include funding limitations, market constraints, and coordination issues in policy implementation [18], [19], [20].

In 2022 UNHCR published access to energy indicators for refugee-hosting countries on the African content. The indicators for Rwanda are presented in Figure 34.

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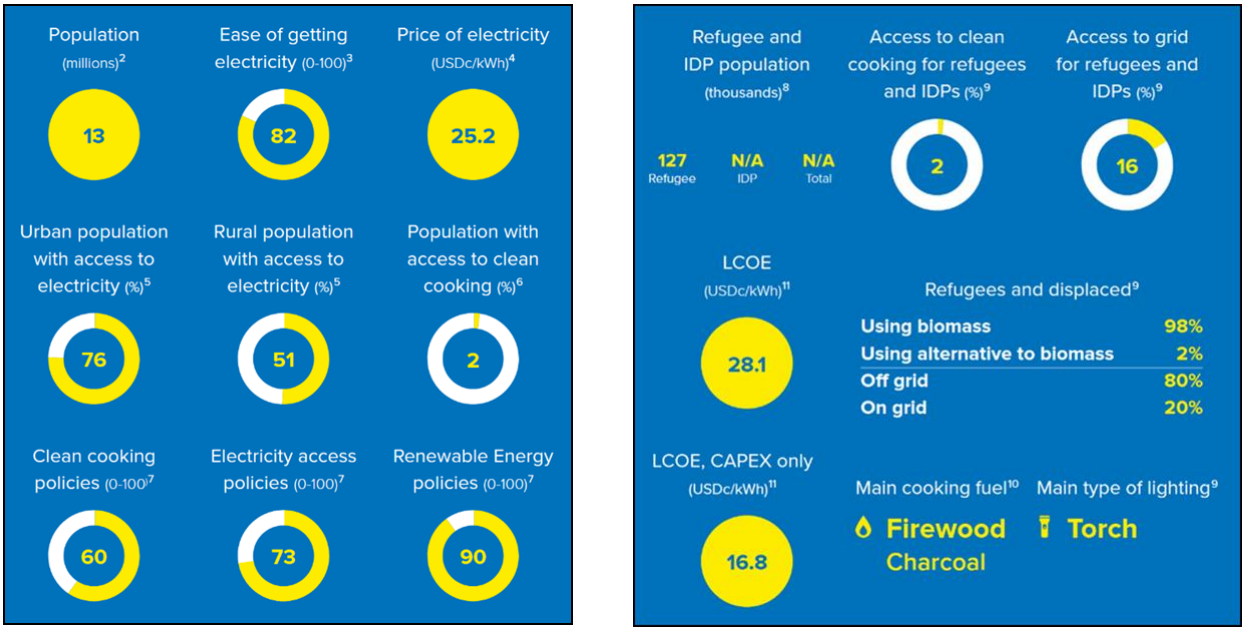

Figure 34: Left - Rwanda´s Host Country Energy Outlook (left), [7, p. 21]; Right - Rwanda´s Host Country Energy Outlook in the displacement context (right), [7, p. 21]

Electricity

Electricity access and usage in refugee camps and host communities in Rwanda show striking disparities and a heavy reliance on off-grid solutions. In settlements such as Kigeme, Nyabiheke, Mahama, Mugombwa, and Kiziba, access to electricity varies significantly in host communities ranging from 43% to 95% and camps ranging from 58% to 88%. In Nyabiheke, Mugombwa and Kiziba the camps show higher access rates than the host communities, whereas in Mahama Camp the access in the host community is 75%. Host communities often benefit from more hours of electricity access per day, particularly in Mahama and Kigeme, where they report 16 to 18 hours, while camp residents typically have 4 to 7 hours. The ability to charge mobile phones using the primary source of electricity is also markedly higher in host communities, with rates peaking at 95% in Mahama, compared to just 24% in Mugombwa camp [11].

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	KIGEME		NYABIHEKE		MAHAMA		MUGOMBWA		KIZIBA	
	CAMP	HC	CAMP	HC	CAMP	HC	CAMP	HC	CAMP	HC
ACCESS TO ELECTRICITY	83%	84%	88%	55%	69%	95%	59%	19%	58%	43%
HOURS OF ELECTRICITY PER DAY	7	16-18	5	5-7	4	16-18	4	5-7	4	5-7
ABILITY TO CHARGE THEIR PHONE USING PRIMARY ELECTRICITY SOURCE	73%	95%	67%	42%	n/a	95%	n/a	24%	n/a	30%

Figure 35: Findings of the RE4R Phase II assessments on household electricity access in camps and host communities, [11]

Cooking

Whilst people in Mahama initially relied on firewood, the Government of Rwanda banned the use of firewood in refugee camps in 2018 to curb deforestation and encourage cleaner energy use. This marked a major shift in camp energy policy, prompting UNHCR to introduce alternative fuels such as LPG, briquettes, and pellets, depending on camp size and logistical feasibility [18], [20]. Following the firewood ban, UNHCR distributed gas-powered stoves and supplies approximately 96,452 kilograms of LPG monthly to Mahama households, with an additional 1,423 kilograms provided to the camp's departure centre [17]. In 2024, the RE4R programme, implemented by Practical Action, further promoted sustainable solutions by selling 21 improved cookstoves and 8,975 kilograms of clean cooking pellets to both refugees and host community members. These efforts contribute to climate mitigation while diversifying energy options and reducing dependence on LPG [17], [18]. However, these interventions have not benefited all households in Mahama [18], [20].

The UNHCR cash-for-energy programme, which had provided financial flexibility to refugees, was discontinued in 2025. Moreover, reliance on LPG alone raises concerns over cost, supply security, and long-term sustainability [18], [20]. Looking ahead, UNHCR and its partners are actively exploring additional alternative energy solutions, recognizing that reliance on LPG alone is not sustainable over the long term.

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5. Overview of data collection activities and data sets

5.1. Introduction and Objective

In line with the overall objective of the system-centred description—namely to establish a structured baseline for understanding the demonstration contexts—this section maps relevant existing data collection activities and available data sets for Uganda and Rwanda. The aim is to (i) identify what evidence already exists on displacement-affected and host-community contexts, energy access, socio-economic conditions, and related thematic areas; (ii) support the interpretation of the context analysis presented in this deliverable; and (iii) provide a practical reference for future SUNNY work by highlighting data sources that can inform continued data acquisition, monitoring, and evaluation, and help avoid duplication of data collection efforts.

5.2. Methodology

The overview was compiled through a comprehensive internet-based search combined with targeted searches in relevant data repositories and academic databases. This included (i) screening websites and portals of key institutions (e.g., humanitarian agencies, governmental bodies, and research organisations), (ii) searching open-data platforms and repositories for downloadable datasets and indicators, and (iii) reviewing scientific and grey literature describing data collection activities, survey programmes, and monitoring systems relevant to the project context. Searches were conducted using thematic keywords (e.g., displacement, refugee/host communities, energy access, cooking, electricity) as well as country- and site-specific terms, and results were screened for relevance to the SUNNY demonstration locations and the scope of Task T1.1. In Rwanda the scope of the search included all refugee camps and in Uganda the scope of search included the refugee settlements in Northern Uganda.

5.3. Results

The findings are presented as a structured set of data sets. The results are split into three parts: (1) data sets covering both countries (Uganda and Rwanda), (2) data sets specific to Uganda, and (3) data sets specific to Rwanda. Within each part, the data sets are summarised in a consistent format (where available), indicating the source/owner, thematic focus, geographic coverage, population focus (e.g., refugee/host

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communities), data type and update frequency, and access conditions. This structure is intended to help readers quickly identify relevant sources for contextual interpretation and to provide a practical reference for subsequent SUNNY activities.

Results: Relevant data collection activities and data sets covering both demonstration countries

The table below (Table 7) summarizes the data collection activities and data sets that provide information for both demonstration countries. The review identified only one data set that was directly relevant and comparable across both demonstration contexts. The table therefore presents this single cross-country source and outlines its key characteristics.

Table 6: Relevant data collection activities and data sets covering both Uganda and Rwanda

Location	Study	Time	Institution	Data	Reference
Sub-Saharan Africa - Uganda and Rwanda	Refugee Settlements Electricity Access (RSEA)	2023-01	European Commission	modelled technical and economic potential for PV mini-grids	https://data.jrc.ec.europa.eu/dataset/4261bf3c-7e8e-4b16-925b-68cfd4eade37

Results: Relevant data collection activities and data sets covering Northern Uganda

The table below (Table 7) summarizes the data collection activities and data sets identified for Uganda that are relevant to the scope of the context analysis. For each entry, the table briefly describes the thematic focus and key characteristics of the data set. Overall, the table is intended as a practical reference to support interpretation of the Uganda context and to indicate where existing data can be used for triangulation and follow-up analysis.

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Table 7: Relevant data collection activities and data sets covering Northern Uganda

Location	Study	Time	Institution	Data	Reference
Ugandan Refugee Settlements	Rapid Assessment of Natural Resource Degradation in Refugee Impacted Areas in Northern Uganda	2019-06	FAO	Wood fuel demand, supply vs local biomass growth, environmental degradation, deforestation & forest degradation	https://documents1.worldbank.org/curated/en/620681548863607633/pdf/Rapid-Assessment-of-Natural-Resources-Degradation-in-Areas-Impacted-by-the-South-Sudan-Refugee-Influx-in-Northern-Uganda.pdf
	READS report Uganda	2023-10	UNITAR	electricity and cooking access	https://www.humanitarianenergy.org/assets/resources/Compress_Uganda_READS_report.pdf
	Energy for Household Uses in Refugee Settlements in Uganda	2024	Ulearn Uganda	Lighting and cooking habits	https://ulearn-uganda.org/wp-content/uploads/2024/01/HUE-Desk-review.pdf
	Energy Practices in Ugandan Settlements Amid Environmental Challenges	2024-04	Ulearn Uganda	energy use and technologies	https://ulearn-uganda.org/wp-content/uploads/2024/04/Energy-Practices-in-Ugandan-Settlements-Amid-Environmental-Challenges_compressed-1.pdf

Bidibidi settlement	Rapid wood fuel assessment	2017	FAO & UNHCR	Rapid wood fuel assessment; supply-demand analysis; household estimates	https://reliefweb.int/report/uganda/rapid-woodfuel-assessment-2017-baseline-bidibidi-settlement-uganda-woodfuel
	Mapping of energy saving solutions in Bidibidi settlement	2020-03	Humanitarian Openstreetmap team	register and statistics of local energy related entities	https://www.mercycorps.org/sites/default/files/2020-08/Fact-Sheet_Energy-Saving-Solutions-in-Bidibidi-Settlement.pdf
Rhino Camp refugee settlement	How night-time streetlighting affects refugee communities: A population-based assessment of community lighting in Northern Uganda's Rhino Camp refugee settlement	2017-12	UNHCR	Impact of streetlights on refugee daily life habits	https://www.unhcr.org/sites/default/files/legacy-pdf/5b3cb5bb7.pdf
Rhino Camp Settlement and Imvepi Settlement	Energy Access in Refugee Settlements: Creating Evidence for Market-Based Approaches	2018-01	GIZ EnDev	Baseline on electricity, lighting and cooking; market, infrastructure and socio-economic barriers identified	https://data.unhcr.org/en/documents/details/64188

	The State of Sustainable Household Energy Access in Refugee Settings in Uganda	2019	GIZ EnDev	Household surveys, market analysis, interviews with energy business owners	https://energypedia.info/images/0/0e/The_State_of_Sustainable_Household_Energy_Access_in_Refugee_Settings_in_Uganda_-_Survey_Findings_in_Rhino_Camp_Settlement_and_Imvepi_Settlement%2C_Arua_District%2C_West_Nile_Region.pdf
	Household cooking fuels, their environmental impacts and community priority interventions in refugee settlements in Uganda	2025-12	CIFOR-ICRAF	Fuel use: firewood, charcoal; fuel-stacking; environmental and social impacts; community views on interventions	https://www.cifor-icraf.org/knowledge/publication/45880/
Ayilo I and Ayilo II refugee settlements	Refugee settlements in transition: Energy access and development challenges in Northern Uganda	2021	Arizona State University	energy use, devices and expenditures	https://www.sciencedirect.com/science/article/abs/pii/S2214629621001961

Results: Relevant Data collection activities and data sets covering Rwanda

The following table compiles the Rwanda-specific data collection activities and data sets identified through the desk review. It highlights key sources that can support the contextualization of Mahama Refugee Camp and the surrounding host-community setting, and that can be used to triangulate and interpret findings presented in this deliverable. For each data set, the table indicates what type of information is captured and summarizes the main features relevant for its use in SUNNY.

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Table 8: Relevant data collection activities and data sets covering Rwanda

Location	Study	Time	Institution	Data	Reference
Kigeme, Nyabiheke and Gihembe refugee settlements	RE4R Policy Brief	2019-12	Practical Action	Used cooking stove types	https://infohub.practicalaction.org/server/api/core/bitstreams/d407f593-22c6-4ce3-8500-b8979b716dab/content
	Ensuring refugee camps in Rwanda have Access to sustainable Energy	2020	Practical Action	electricity and cooking access	https://beamexchange.org/resources/resource-library/1582/
	The diffusion of Solar Home Systems in Rwandan refugee camps	2021	Thomas, P., Williamson, S., & Harper, P. W. (2021), University of Bristol	Solar home systems customers: economical and financial situation as well as impact	https://research-information.bris.ac.uk/ws/portalfiles/portal/282165224/Paper_3_Final_Accepted_Version.pdf
Rwanda with special chapter on refugee households	Rwanda - Energy Survey : Insights into Energy Access in Rwanda Using the Multi-Tier Framework	2022-06	World Bank Group	Energy Access regarding the Multi-Tier Framework	https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099090324174097394/p17742918589980941b23e1e4c5b58cdfa5

Rwandan Refugee Camps	READS report Rwanda	2023-12	UNITAR	electricity and cooking access	https://www.humanitarianenergy.org/assets/resources/READS_Rwanda_Final.pdf

6. PHOTO ESSAY OF THE LOCAL CONTEXTS

This section presents a short photo essay that complements the system-centred description by adding a visual layer of contextualization. Rather than introducing entirely new findings, the photo essay supports interpretation of the chapter by illustrating key aspects of the local contexts and the lived environment in and around the demonstration locations. The photographs and accompanying captions draw on observations made during field visits, as well as information gathered through interviews and unstructured conversations conducted in the refugee settlement/camp and surrounding areas. In addition, some of the photographs were taken by the local research assistants as part of the preparation for the context survey, providing further site-based visual documentation from the field.

The photo essay is organised intentionally to mirror the structure of the descriptive parts of the system-centred chapter. It therefore begins with images that contextualise the broader local setting (e.g., settlement/camp environment, infrastructure, everyday spaces and services) and subsequently focuses on energy-relevant aspects. In doing so, the section is particularly relevant for readers who have not had the opportunity to visit the demonstration locations, providing an accessible reference that helps to situate the written analysis in the realities of the field sites.

6.1. Bidibidi and the host community

This subsection presents the photo documentation for Bidibidi Refugee Settlement and the surrounding host community in two parts. It starts with images that capture key features of the broader local setting and everyday environment, providing a visual impression of the context in which households live and services are delivered. It then moves to an energy-specific set of photographs that highlight selected energy-related infrastructure and practices relevant to understanding current access conditions and local energy challenges.

Bibibidi and the host community: General context

Arua is the principal urban hub of Uganda's West Nile region and serves as the operational base for many national and international NGOs. Its location near the borders with South Sudan and the Democratic Republic of Congo makes it a central coordination point for humanitarian activities across the region, including support to large refugee settlements such as Bidibidi. An aerial of view of Arua is depicted in Figure 36.

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Figure 36: Areal view of Arua. Arua is a regional commercial hub and the location of the regional headquarters of many actors engaging in the humanitarian sector. Reaching the basecamp of Bidibidi from Arua takes approximately 2,5 hours by car.

While many households in the Bidibidi host community lie in close proximity to the national electricity grid, this does not imply that they are connected. Physical closeness to the grid often contrasts with the limited number of actual household connections. Figure 37depicts a village that is located next to a powerline but is not connected grid. grid.

Figure 37: Village in the host community near Arua

In Figure 38Figure 38, a village in Bidibidi is depicted. The shelters in the village have plastic tarps as roofing. The presence of temporary plastic tarp roofs can indicate that the households in this part of Bidibidi are comparatively new.

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Figure 38: Village in Bidibidi Settlement. The temporary roofing of the shelter suggests a more recent arrival of the residents in Bidibidi settlement.

Many households in Bidibidi engage in farming activities. Figure 39 shows a village together with the surrounding land used for cultivation. Figure 40Figure 40 shows an individual house along with the adjacent plot of land that is used for farming.

Figure 39: Example of a village with associated fields for crop production in Bidibidi Settlement

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Figure 40: Plot of land divided into an area for the shelter and a garden.

Villages that have a market area are typically more densely populated and contain a higher number of households. The following image shows such a market area. Although the market area is connected to the grid, this does not mean that shops within it are connected. Figure 41 shows a central market area in Bidibidi.

Figure 41: Market area is a central location of Bidibidi. The image further displays a "complaints box" set up by UNHCR.

Bibibidi and the host community: energy environment

This section presents photos of different common cookstoves, cooking fuels and lighting options. The photos shown were taken by the local research assistants and were utilized

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during the contest survey (see Chapter 0).

The refugee and host community in Bidibidi utilizes a variety of cookstoves. A selection of the most common stove type is shown in Table 9. These include (from left two right and top to bottom) (a) three-stone stove, (b) traditional all-mud stove, (c) traditional all-metal stove, (d) improved mud stove, (e) improved charcoal stove, and (f) gasifier stove. Apart from the visualized stoves paraffin stoves, and solar cookstoves can also be found in the refugee and host community.

Table 9: Selection of the most common cookstove types in Bidibidi. From left two right and top to bottom: (a) three-stone stove, (b) traditional all-mud stove, (c) traditional all-metal stove, (d) improved mud stove, (e) improved charcoal stove, and (f) gasifier

 *(a)*	 *(b)*
 *(c)*	 *(d)*

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(e)

(f)

A selection of the most common stove type is shown in Table 10. These include (from left two right and top to bottom) (a) firewood, (b) charcoal, (c) biowaste. Apart from the visualized cooking fuels pellets, and briquettes can also be found in the refugee and host community.

Table 10: Selection of cooking fuels used in Bidibidi. From left two right and top to bottom: (a) firewood, (b) charcoal, (c) biowaste

(a)

(b)

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(c)

A selection of the most common lighting options is shown in Table 11. These include (from left two right and top to bottom) (a) lighting from a mobile phone, (b) light bulbs powered through a solar home system, (c) paraffin lamp, and (d) solar lanterns. Apart from the visualized lighting options, lighting from open fire, candles, battery powered torches, rechargeable torches, open wick lamps, and lighting using electricity from the gird is also generally available.

Table 11: Selection of common lighting technologies in Bidibidi. From left two right and top to bottom (a) lighting from a mobile phone, (b) light bulbs powered through a solar home system, (c) paraffin lamp, and (d) solar lanterns

(a)

(b)

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(c)

(d)

6.2. Mahama and the host community

This subsection presents the photo documentation for Mahama Refugee Camp and the surrounding host community in two parts. It begins with photographs that illustrate key characteristics of the broader local setting and everyday environment, helping to visualize the context in which households live and services are organized. It then shifts to an energy-specific set of images that highlight selected energy-related infrastructure and practices relevant for understanding current access conditions and local energy challenges.

Mahama and the host community: General context

In the Mahama host community, several villages have access to the national electricity grid. Figure 42 and Figure 43 depict two households in the host community of Mahama that are connected to the electricity grid.

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Figure 42: Typical housing in a host community village of Mahama. The power lines indicated that the household is connected to the national grid

Figure 43: Housing in the host community of Mahama. The satellite dish indicated that the household is using a television.

Within the campgrounds of Mahama there are a total of three markets. In addition to the internal markets, refugees also have access to an external market just outside the camp, where businesses are operated by both camp residents and members of the host Rwandan community. provide space for small-business activities (e.g., food retail, clothing, household goods, handicrafts). Figure 44Figure 44 shows one of the markets in Mahama. Figure 45 shows several houses in Mahama. Figure 46 shows an area with tents that are used as storage spaces, and a streetlight. Mahama is located close to the boarder to Tanzania. The vegetation in the background of Figure 46 is located in Tanzania.

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Figure 44: Picture of a market in Mahama.

Figure 45: Housing, vegetation and a road in Mahama

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Figure 46: Storage area in Mahama.

At Mahama Refugee Camp, an agricultural cooperative was formed as part of the Climate Resilient Farming for Refugees initiative implemented by Practical Action. The cooperative brings together refugee and host-community farmers to work collectively—sharing land, irrigation infrastructure and marketing links—to improve production, income and resilience to climate shocks. Under the project, members were trained in regenerative farming, farm business planning and market access, enabling them to sell produce at higher prices and gain more stable livelihoods. Figure 47 shows agricultural land in Mahama.

Figure 47: Parts of Mahama refugee camp make up fields that are use for agricultural activities. Agricultural activities are organized through a cooperative.

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The use of firewood for cooking has been officially banned in Mahama Refugee Camp, leading to a full transition toward cleaner cooking fuels. As a result, households now receive Liquefied Petroleum Gas (LPG) through regular distribution. The quantity of LPG provided is not uniform across the camp; instead, it depends on each household's support category as well as the number of people in the household. Figure 48 shows LPD cylinders stored in a storage unit in Mahama.

Figure 48: The photo shows a storage unit in Mahama, in which LPG cylinders are stored.

Mahama and the host community: energy environment

This section presents photos of different common cookstoves, cooking fuels and lighting options. The photos shown were taken by the local research assistants and were utilized during the contest survey (see Chapter 0).

The refugee and host community in Bidibidi utilizes a variety of cookstoves. A selection of the most common stove type is shown in Table 12. These include (from left two right and top to bottom) (a) three-stone stove, (b) traditional all-mud stove, (c) improved charcoal stove without a fan, (d) improved charcoal stove with a fan, (e) improved cookstove for firewood, and (f) LPG cookstove. Apart from the visualized electrical cookstoves can also be found in the refugee and host community.

Table 12: Selection of available cookstoves in Mahama and the host community. From left two right and top to bottom: (a) three-stone stove, (b) traditional all-mud stove, (c) improved charcoal stove without a fan,

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(d) improved charcoal stove with a fan, (e) improved cookstove for firewood, and (f) LPG cookstove

(a)

(b)

(c)

(d)

(e)

(f)

A selection of the most common stove type is shown in. These include (from left two

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right and top to bottom) (a) firewood, and (b) charcoal. Apart from the visualized cooking fuels pellets, briquettes, and LPG can also be found in the refugee and host community.

Table 13: Selection of cooking fuels used by the refugee and host community. From left two right: (a) firewood, and (b) charcoal

	
(a)	*(b)*

A selection of the most common lighting options is shown in Table 14Table 11. These include (from left two right and top to bottom) (a) Solar home systems, (b) battery powered torch, and (c) solar torch. Apart from the visualized lighting options, lighting from open fire, candles, kerosene lamp, lighting from mobile phone, solar lantern, lighting through electricity from the grid.

Table 14: Selection of common types of lighting in the household. From left two right and top to bottom: (a) Solar home systems, (b) battery powered torch, and (c) solar torch

	
(a)	*(b)*

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(c)

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IV. PERSON-CENTRED ANALYSIS

As outlined in the overall methodology, the contextual analysis under Task T1.1 is organized into four complementary components that together build a comprehensive understanding of the demonstration contexts in Rwanda and Uganda. This chapter documents the person-centred analysis component (see Figure 49**Error! Reference source not found.Error! Reference source not found.**). It focuses on community perspectives and lived experiences by exploring everyday life, wellbeing, and access to energy services in both refugee and host communities. The chapter draws on participatory workshops and household context surveys to identify priorities, constraints, and energy service needs, and to enable comparison across population groups and the two country contexts. As such, it provides the user- and community-focused evidence base that complements the system-centred description, the environmental analysis, and the regulatory and policy analysis within the wider methodological framework described in Chapter III (Overall methodology).

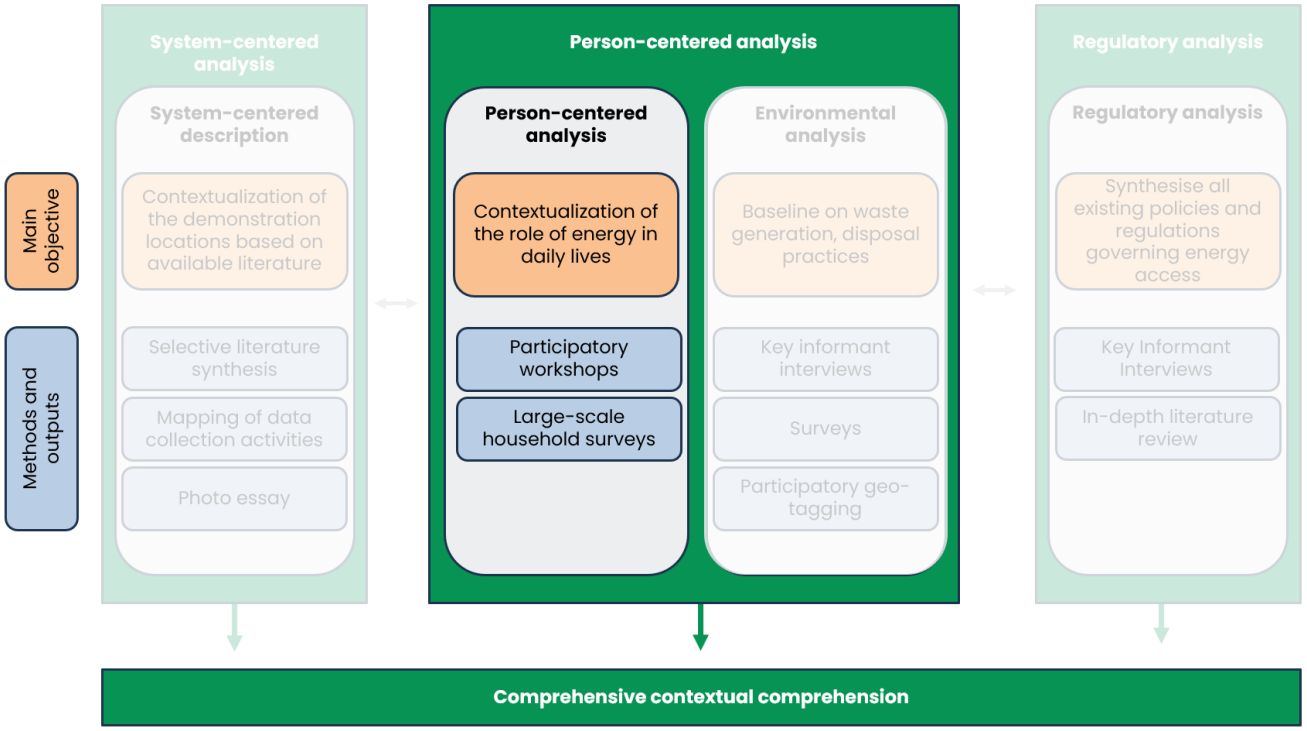

Figure 49: Person-centred analysis as part is one component in the overall methodology.

The chapter is organized into three main sections. First, the Introduction and objective section explain the purpose of the person-centred analysis within Deliverable D1.1 and outlines how this component contributes to the overall contextual analysis framework. Second, the Methods section describes the two main empirical approaches used to generate person-centred evidence: participatory community workshops and household

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context surveys. It explains the rationale for selecting each method, summarizes the key steps of implementation, and clarifies how insights from the workshops informed the development of the survey instrument, as well as how data were collected across the two demonstration contexts. Third, the Results section presents the findings in two complementary subsections: Results - Workshops (documenting workshop outputs in the same step-by-step order in which topics were addressed) and Results - Context survey (providing a structural overview of the survey findings and referring readers to the separate country survey results reports for the full quantitative outputs).

1. Introduction and Objective

The person-centred analysis goes beyond the description of the local energy ecosystem and aims at uncovering and documenting the perspectives of the local communities. It aims to systematically establish an understanding of the underlying challenges that energy services can address, and a basic understanding of the diversity of perspectives on subject matters related to energy access. The person-centred analysis therefore addresses the fundamental gap of a lack of integrating local perspectives in developing energy introduce in displacement contexts.

Overall objective:
The main objective of the person-centred analysis is to establish an understanding of energy-related themes from the perspective of the local communities. Specifically, the overarching research questions addressed in through the person-centred analysis include (1) establishing an understanding of the role of energy services contribute to the daily functioning and quality of life, and (2) uncovering energy service needs and local capacities to facilitating an enhanced access to energy services. Beyond the content-related objectives, this person-centred analysis aims for advancements in participatory research both in the SUNNY project and beyond.

Methodically the research activities are composed of two main activities (1) a series of workshops, and (2) a household survey.

Specific objective of the series of workshops
The workshops were conducted to generate a structured, person-centred understanding of everyday life, wellbeing, and energy access in the demonstration locations, and to ensure that community perspectives meaningfully inform subsequent SUNNY activities. The workshop brought together diverse voices from both refugee and host communities (including variation by age, gender, disability, and community roles) to capture different experiences, priorities, and constraints.

The specific objectives of the workshops are:

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1. Identify and prioritise persisting challenges faced in the communities
2. Build a shared basic understanding of energy concepts (including the concept of "energy services")
3. Map which energy services are currently accessible, what challenges are associated with these services, and what is needed to overcome barriers and achieve improved access.

Specific objective of the household survey

Building on the insights generated through participatory workshops, the survey was designed to translate qualitative findings into robust quantitative evidence, while capturing diversity across groups and sub-groups in the local context.

The specific objectives of the context survey are:

1. Establish a demographic and socio-economic baseline by systematically characterizing the refugee and host communities and capturing key dimensions of diversity within and across them
2. Contextualize the role of energy in everyday life and wellbeing. This includes:
    - assessing how different energy services contribute to what people value in daily life and to perceived quality of life
    - identifying the most prominent challenges in daily life and the relative role of energy-related versus non-energy-related constraints
    - documenting and comparing priorities for improving energy services, including differences across socio-demographic and contextual variables and across refugee/host populations
3. Contextualize the state of access to energy services and identify capacities for enhancements by proceeds from baseline perceptions to progressively more detailed layers of evidence, culminating in implications for targeted action. This includes:
    - measuring knowledge and awareness, and perceived availability of specific technologies as preconditions for access
    - documenting how services are accessed in practice
    - identifying persistent challenges and constraints
    - identifying existing and potential support structures, resources, and community capacities that enable access
    - capturing indications of consistency and change in service use

Further the results presented differentiate local conditions between refugee and host communities by systematically comparing access patterns, priorities, constraints, and enabling factors across the two population groups.

Together, these objectives ensure that the context survey provides a structured,

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community-grounded baseline on energy service access and needs, and supports subsequent SUNNY activities that require locally differentiated evidence for solution design and implementation

2. METHODS

The person-centred analysis follows a mixed-methods approach. Methodically the two main components of the approach cover (1) a series of workshops, and (2) a household survey. The methodological approaches are described in detail in the following to subsections.

2.1. Methods - Workshops

The series of workshops conducted in Mahama and Bidibidi were conducted with representatives of the local refugee and host communities in the demonstration locations and allow for diverse insights into the local context that are not accessible through desk-based research.

As a participatory format, the workshops were selected to allow a stepwise exploration of topics—moving from general questions about daily life and wellbeing to more specific questions on energy and energy service needs—while enabling broad representation of community perspectives and combining individual reflection, group discussion, and facilitated input sessions. The design of the workshops was guided by Vaughn and Jacquez [1] and Castro-Diaz [2].

Choice of workshops as a format

Prior to selecting workshops as a format, the objectives of the participatory dimension of the research were established. Subsequently, the feasibility of different participatory formats in the demonstration sites were mapped and discussed. This included considerations of what kind of formats typically are used to have meetings and exchanges in Bidibidi and Mahama. Workshops were identified as the most relevant format for the objectives of the activity.

Workshops were selected as a suitable format because they enabled the research team to address a sequence of questions in a structured way, gradually developing the discussion from general topics related to daily life and wellbeing towards more specific issues such as energy access and energy needs. The format also supported the representation of large parts of the communities, allowing a broad range of perspectives to be included. In addition, workshops combined multiple modes of participation—individual inputs, group discussions, and facilitated input sessions—which helped to capture both personal experiences and shared community priorities. Finally,

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the workshop set-up made it possible to carry out several different activities within a relatively short period of time, increasing efficiency while maintaining a participatory approach.

The development of the workshop materials was broadly informed by Parent [3].

Selection of research participants

The selection of workshop participants was closely coordinated between the research leads, and the local facilitating partners. The aim of the participant selection was to have diverse perspectives in the community represented.

Key considerations for the selection of workshop participants were:

- Representation of persons from both the host and refugee communities
- Representation of different ages
- Representation of different genders
- Representation of persons with disabilities
- Representation of religious communities
- Representation of education and health sector
- Representation of persons involved in business matters
- Representation of persons with expertise in energy
- Community leaders representing different institutional levels

Overall approach of the workshop

The workshop concept covered the following elements:

a) Input and discussion: Introduction to the workshop and consent in research
b) Research Exercise: Challenges in everyday life (individual and community perspective)
    - We asked participants to reflect individually and subsequently moderated an open discussion to compile relevant answers to dedicated questions.
c) Research Exercise: Prioritization of challenges
    - Participants were asked to state their individual priorities for a given list of challenges. The challenges were derived from answers that were previously given in exercise b).
d) Input and discussion: What is energy and what are energy services?
    - This session was designed to be interactive. First, we established the existing knowledge on energy among the workshop participants. Second, existing

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knowledge was shared among participants. Third, based on what was shared by participants, we gave an input focusing on different types of energy, different usages of energy, and the concept of energy services.

e) Research exercise: (Lack of) Access to energy services
   - We asked participants to reflect individually and subsequently moderated an open discussion to compile relevant answers to dedicated questions.

f) Research Exercise: Prioritization of energy services
   - Participants were asked to state their individual priorities for a given list of energy services

g) Research Exercise: Energy products and energy infrastructure
   - We asked participants to reflect individually and subsequently moderated an open discussion to compile relevant answers to dedicated questions.

h) Discussion: Extended feedback session

2.2. Methods - Household surveys

Based on the comprehensive insights from the workshops, context surveys for Uganda and Rwanda were conceptualized. The term "context survey" is used to differentiate this baseline survey from other SUNNY survey instruments. The results from the context survey are presented in this document. The context surveys were implemented to document socio-economic conditions and current energy use, with a focus on cooking practices, costs, and access challenges. The results from the context survey are presented in this document.

Context survey conceptualization

The household survey instrument was developed by systematically translating key outputs from the participatory workshops into survey modules and question wording. Workshop results informed the survey in three ways: (i) priorities and challenges identified in daily life were operationalized into structured questions on socio-economic constraints shaping energy access; (ii) discussions on energy services guided the selection and framing of the survey's core energy access questions (patterns, barriers, unmet needs); and (iii) insights on energy products and infrastructure informed items on technology use, access mechanisms, and practical constraints, using locally relevant terms where possible. Overall, the survey complements the workshops by quantifying and enabling comparison of key themes across refugee and host communities and across the two demonstration contexts. The technical design of the survey was guided by Stockemer [4].

By building on the workshop results, the survey content was aligned with locally

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grounded terminology and priorities, and it targeted those aspects of energy access that workshop participants highlighted as most relevant for daily life and wellbeing. The household survey therefore complements the workshop-based evidence. While the workshops provide depth and contextual understanding, the survey provides scale and quantification, allowing the project to assess the prevalence of observed patterns and to strengthen the evidence base for subsequent SUNNY activities.

Context survey development

The household survey was developed in close collaboration with local research assistants through an iterative design process. This collaboration combined regular (weekly) coordination meetings, on-site workshops, and multiple feedback loops, enabling continuous exchange of methodological considerations and contextual knowledge. Throughout the process, research assistants provided detailed input on question formulation, cultural appropriateness, and field feasibility, and supported the adaptation of the questionnaire to local implementation realities. Collaboration with the research assistants was also essential for ensuring language accessibility and clarity.

Research preparations

The surveys were based on a structured questionnaire with closed- and open-ended mixed questions. The questionnaire was prepared in English language and then translated into relevant languages. The questionnaire was prepared in English and translated into the relevant local languages for implementation. In Rwanda, the survey was conducted mainly in Kinyarwanda and English. In Uganda, the survey was translated and conducted in English, Aringati, and Arabic to reflect the linguistic diversity of refugee and host communities.

Sampling and recruitment

The survey followed a two-stage cluster sampling design, drawing on the approach proposed by Bennett et al. [5] and adapted to the local context: clusters (e.g., villages/settlement sections) were selected first, followed by sampling of households within selected clusters. In this approach, the overall population is first divided into smaller, naturally occurring groups or “clusters”, such as villages, neighbourhoods, or administrative zones within the camp and host communities. A random selection of these clusters is then made to capture the diversity of living conditions and social contexts. Finally, data are collected from all individuals within the chosen clusters, or from a random sample of individuals within those clusters, depending on population size and accessibility.

The total number of surveys in each demonstration location was specified following recommendations by Memon et a. [6]. The sampling ratio of one-third host community and two-thirds refugee community was chosen to reflect the demographic realities. In

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both demonstration sites, the refugee population is significantly larger than that of the immediate host communities.

In Rwanda, the villages of the refugee and host community were considered as the research clusters. The total number of interviews for each community was divided by the number of villages in each community and thereby the target number of interviews per village was derived. By applying this method, it was assured that every village was covered evenly.

Specifying the sample structure for the data collection Uganda was more complex. Bidibidi is organized into five administrative zones, each comprising multiple villages (see Table 15). The zones differ in geographic extent and total population. Using the available household statistics for each zone, the research team calculated the relative distribution of households and, on this basis, determined the number of villages to be included per zone. A random selection of villages was performed using Microsoft Excel to generate the final list of sampling locations (see Table 16). For the host community limited information is publicly available on the villages within the geographical scope of Bidibidi. Following the selection of villages in the refugee community, associated villages in the host community were selected for which information was available. This information is documented in SUNNY deliverable D2.2. This approach ensured both statistical representativeness and logistical feasibility, allowing for the inclusion of diverse perspectives across the settlement while maintaining methodological rigor.

Table 15: Number of households and villages in Bidibidi per zone, and number of villages selected as part of the sample per zone

Zone	Total Nr. of house holds	Total Nr. of villages	Total Nr. of villages included
Zone 1	7455	14	5
Zone 2	8455	11	6
Zone 3	11216	16	8
Zone 4	6074	10	4
Zone 5	9583	24	7

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Table 16: Selection of specific villages included in the sample per zone in Bidibidi.

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	4	1	3	2
4	5	2	4	7
8	6	3	5	9
13	7	5	8	10
14	10	6		15
	11	10		16
		12		18
		15		

Table 17: Implementation plan and overview of villages in the host community and refugee community

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included in the sample of the survey

Day	Zone	Village in refugee community: (minimum 8 per village)	Village in host community: (minimum 8 per village)
1	Zone 1	1	Bidibidi
2		13	Twajiji West
3		14	Geluru
4	Zone 2	6	Nyunru
5		7	Mulondo
6		4	Invimvi
7	Zone 3	1	Para
8		3	Ojurukonga
9		5	Mengo
10		15	Limu
11	Zone 4	4	Malanga
12		8	Bolomoni
13	Zone 5	7	Yangani
14		15	Ayivu
15		20	Ochinga
16		23	Okubani
17	Zone 1	4	
18		8	
19	Zone 2	5	
20		10	
21		11	
22	Zone 3	2	
23		6	
24		10	
25		12	
26	Zone 4	3	
27		5	
28	Zone 5	2	
29		16	
30		18	

Data Collection Procedure

Surveys were conducted through face-to-face interviews in respondents' preferred language, facilitated by trained local enumerators. The tool was programmed into KoBo Toolbox (EU server) for digital data entry, enabling standardized answer recording and minimizing data entry errors. Each interview lasted approximately 60-80 minutes.

Informed consent was obtained verbally and in writing. People who cannot write gave their consent with a fingerprint. Respondents were assured that participation would not affect their assistance status and that they could decline to answer any question or

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withdraw at any time without consequence. To protect privacy, personal identifiers were replaced with unique codes.

Survey administration

This subsection summarizes how the survey was administered, including the survey mode, the overall sample size and composition (refugee and host community), key respondent characteristics, the geographic sampling approach, and the languages used during data collection.

Survey administration in Rwanda:

- Survey mode: digital (KoboToolbox)
- Number of participants: A total of 352 participants (N) were surveyed for this assessment.
- Ratio of refugee and host community members: Two thirds of participants were from the refugee community (total: 234 refugee community members (N_r)) and one third were from the host community (total: 118 host community members(N_h))
- Gender distribution: 49,7 % female, 50,3 % male
    - Refugee community: 50,4% female, 49,6% male
    - Host community 48,3% female, 51,7% male
- Geographic distribution:
    - Cluster sampling was applied
    - Refugee community: Mahama refugee camp is organized 18 villages. Villages in Mahama are of similar size and each village presented one cluster for the sampling. A total of 13 surveys were conducted in each village in the refugee community.
    - Host community: The host community can be considered the resident of the Munini cell located in Mahama sector. Each of the ten villages in the cell were considered as an individual cluster. In each village either a total of either eleven or twelve surveys were conducted.

Table 18: Overview of villages that were included in the host community sample for the context survey

	Village	Number of Households
1	Munini	286
2	Kabeza	118
3	Rebero	183
4	Huriro	162

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5	Kagera	98
6	Ruhondo	117
7	Karambi	120
8	Remanyundo	209
9	Rugarama	130
10	Nyenyeri	115

- Language in which survey was conducted:
    - Refugee community: In the refugee community 74,5 % of surveys were conducted in Kinyarwandan, 25,6% of surveys were conducted in English.
    - Host community In the host community all surveys were conducted in Kinyarwandan.

Survey administration in Uganda:

- Survey mode: digital (KoboToolbox)
- Number of participants: A total of 381 participants (N) were surveyed for this assessment.
- Ratio of refugee and host community members: Two thirds of participants were from the refugee community (total: 256 refugee community members (N_r)) and one third were from the host community (total: 125 host community members(N_h))
- Gender distribution: 50,7 % female, 49,3 % male
    - Refugee community: 50,4% female, 49,6% male
    - Host community 51,2% female, 48,8% male
- Geographic distribution:
    - Cluster sampling was applied
    - Bidibidi refugee settlement is organized into five administrative zones, each comprising multiple villages. The zones differ in geographic extent and total population-
    - For geographical representativeness, respondents were selected from all five zones of the Bidibidi settlement. Using the available household statistics for each zone, the research team calculated the relative distribution of households and, on this basis, determined the number of villages to be included per zone. A random selection of villages was performed using Microsoft Excel to generate the final list of sampling locations.
- Language in which survey was conducted:
    - Refugee community: In the refugee community 71,1 % of surveys were conducted in Arabic, 1,2% of surveys were conducted in Aringa, 25,8% of

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surveys were conducted in English, and 2% of surveys were conducted in Kakwa.

- Host community In the host community 99,2% of surveys were conducted in Aringa, and 0,8% of surveys were conducted in English.

Specifying the sample structure for the data collection Uganda was more complex. Bidibidi is organized into five administrative zones, each comprising multiple villages. The zones differ in geographic extent and total population. Using the available household statistics for each zone, the research team calculated the relative distribution of households and, on this basis, determined the number of villages to be included per zone. A random selection of villages was performed using Microsoft Excel to generate the final list of sampling locations. This approach ensured both statistical representativeness and logistical feasibility, allowing for the inclusion of diverse perspectives across the settlement while maintaining methodological rigor.

Table 19: Number of households and villages in Bidibidi per zone, and number of villages selected as part of the sample per zone

Zone	Total number of households in the zone	Total number of villages in the zone	Total number of villages included in the survey
Zone 1	7455	14	5
Zone 2	8455	11	6
Zone 3	11216	16	8
Zone 4	6074	10	4
Zone 5	9583	24	7

Table 20: Selection of specific villages included in the sample per zone in Bidibidi.

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	4	1	3	2
4	5	2	4	7
8	6	3	5	9
13	7	5	8	10
14	10	6		15
	11	10		16
		12		18
		15		

2.3. Ethical Considerations

All activities carried out under Task 1.1 adhered to strict ethical standards to ensure the

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safety, dignity, and rights of participants and research assistants. Prior to data collection, the project partners organized workshops with all research assistants to provide training on ethical interviewing practices, including guidance on avoiding any situation that could compromise their own safety and protocols for disengaging immediately if they felt threatened or uncomfortable. Enumerators were also trained to recognize signs of participant distress and to pause, redirect, or terminate interviews as needed to prevent discomfort.

All participants were informed about the purpose of the research, the voluntary nature of their involvement, and their right to withdraw at any moment during the interview and up to two weeks after participation. They were also assured that participation was independent from humanitarian assistance and would not affect their access to services. To protect confidentiality, a two-step data protection procedure was applied: during the two-week withdrawal window, names were securely stored only to allow participants to retract their data; after this period, the participant list was destroyed and identifying information could no longer be linked to survey codes. The questionnaire was designed to avoid sensitive or potentially harmful topics, limiting the risk of psychological discomfort. These measures ensured that data collection complied with ethical research standards and respected the rights and well-being of all involved.

3. Results

This section presents the results of the person-centred analysis and summarizes the key findings generated through the participatory workshops and the context surveys conducted in the two demonstration locations (Uganda and Rwanda). To support readability and navigation, results are structured by data source and presented in two subsections: (1) Results - Workshops, which documents the step-by-step outcomes of the workshop discussions and exercises, and (2) Results - Context survey, which provides a high-level overview of the survey results and explains how the detailed quantitative findings are presented in the separate country results reports. Together, these two subsections provide complementary evidence: the workshop results offer participatory depth and contextual understanding, while the context survey results add scale, quantification, and systematic comparison across population groups and sites.

3.1. Results: Workshops

The documentation of the workshops enables concrete insights into local challenges, diverse perspectives on the role of energy, energy needs and implications of access to energy in the local contexts.

Introducing the workshop results

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The workshops were designed to be explorative to openly identify relevant topics and questions. Participants were selected specifically to represent a wide variety of subgroups in the communities. The results therefrom inform us about aspects and elements to take into consideration for subsequent research.

For some of the results the number of participants who gave the respective answer is stated. A high number points towards a general awareness of a subject matter and a high relevance of the subject matter. However, the number of participants who gave the respective answer is not statistically relevant. It may be understood as an indication. It is important to highlight that it is likely that certain subject matters may only be relevant for a subgroup within the communities, but the subject matter may be of high relevance for this subgroup (e.g., specific mobility issues that some persons with disabilities may have).

Overview the workshop results

The following table provides an overview of the insights that were derived from the workshop results. The table states (1) Insights – the type of output that was generated, (2) The name of the document through which the results are available for project partners on the project's shared drive. A more comprehensive explanation of the various insights that have been generated based on the workshop results is provided in the following.

Table 21: Overview of insights derived from the results of the workshops in Bidibidi and Mahama

#	Insights	Document
	Activities and challenges in the daily lives of community members:	
1	Overview of activities in the lives of members of the communities	1_UG_Workshop Evaluation_Daily Activites
2	Overview of challenges in the communities	2_Workshop Evaluation_UG_Challenges; 2_Workshop Evaluation_RW_Challenges
3	Overview of priorities of challenges	2_Workshop Evaluation_UG_Challenges; 2_Workshop Evaluation_RW_Challenges
	Access to and relevance of energy services:	
4	Overview of energy services accessible in the communities	3_Workshop Evaluation_UG_Energy Services Accessable; 3_Workshop Evaluation_RW_Energy Services Accessable
5	Overview of challenges associated with energy services that are accessible in the communities	3_Workshop Evaluation_UG_Energy Services Accessable; 3_Workshop Evaluation_RW_Energy Services Accessable

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6	Overview what is needed to overcome challenges	3_Workshop Evaluation_UG_Energy Services Accessable; 3_Workshop Evaluation_RW_Energy Services Accessable
7	Overview of energy service needs in the communities	4_Workshop Evaluation_UG_Energy Services Needs; 4_Workshop Evaluation_RW_Energy Services Needs
8	Overview of what is needed to achieve access to additional energy services	4_Workshop Evaluation_UG_Energy Services Needs; 4_Workshop Evaluation_RW_Energy Services Needs
9	Overview of (positive) impact of achieving access to energy services	4_Workshop Evaluation_UG_Energy Services Needs; 4_Workshop Evaluation_RW_Energy Services Needs

Structure of the workshop results

The workshop results are presented in the same step-by-step sequence in which topics were addressed during the workshops, moving from broad reflections on everyday life and wellbeing towards increasingly specific questions on energy access and energy service needs. This structure mirrors the workshop design, which was intentionally organised as a gradual progression from (i) identifying and discussing key aspects of daily life and persisting challenges, to (ii) prioritising these challenges, and then to (iii) introducing energy concepts and systematically exploring energy services, barriers, and needs.

Accordingly, the results that follow are organised as: (1) activities in daily life, providing a baseline for understanding routines and requirements; (2) persisting challenges in the communities and their prioritisation, to clarify which constraints are perceived as most critical; (3) an overview of energy services currently accessible, including the challenges associated with these services and what is needed to overcome barriers; and (4) energy service needs, including what would be required to achieve access to additional services and the expected (positive) impacts of improved access.

To support comparability across the two demonstration contexts, the results are presented first for Uganda following this structure and sequence, and subsequently for Rwanda following the same sequence and headings.

Uganda: Activities in the lives of members of the communities

In the following we present an overview of activities in the daily lives of members of the communities. The activities were derived from dedicated questions during the workshop. The activities were grouped and categorised as part of the evaluation. The categories were not predefined.

The answer categories that evolved during the consolidation exercise are the following:

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- WASH
- Food
- Occupation, farming, and animal breeding
- Daily obligations
- Leasure, praying, and education
- Family care
- Community work

Table 22: Overview of activities in the lives of members of the communities in Bidibidi and host community

Category	Group	Activities	Alternative Wording (1)	Alternative Wording (2)	Frequ.
WASH		Brushing teeth	Cleaning teeth		15
		Going to the toilet			1
		Washing face			6
		Washing latrines			1
		Taking bath	Taking a shower		11
Food		Taking tea (morning)			2
		Preparing breakfast			2
		breakfast			9
		Eating			2
		Cooking food			5
		Preparing breakfast			1
		Preparing lunch			2
		Eating lunch			6
		Preparing dinner			2
		Eating food (dinner)	Having supper		6
Occupation, farming, and animal breeding	Farming	Go to the garden	farming activities	Going to dig	10
	Animal Breeding	Bringing goats from bush			1
		Taking goats for grazing			1
		Keeping poultry			1
	Occupation and Livelihood	Teaching	Teaching the learners		2

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		Dealing with management matters at school			1	
		Dealing with administrational matters at school			1	
		Supervising Village-Health-Teams (mentorship)			1	
		Activities regarding social and behaviour change communication (SBCC)			1	
		Health work in the community			1	
		Home visits and follow-up examinations of patients (health work)			1	
		Working at the office	administrative work		1	
		Looking after animals			1	
		Working			1	
		Going for work			1	110
		go for business	Going to look for money in the trading centre		1	
		Gold mining			1	
	Search for employment	Searching for employment			1	
Day-to-day obligations and activities	Daily activities	Getting dressed			4	
		sleeping (at night)			6	
	Cleaning activities	Cleaning compound	Cleaning home		4	
		Cleaning the road			1	
		Sweeping	Sweeping the compound	Sweeping the room	5	
		Cleaning the kitchen			1	
		Washing utensils			1	
		Washing clothes			1	

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		Polishing shoes			1
	Collecting and buying of products	Going to market			3
		Fetching water			5
		Collecting firewood			1
		Buying charcoal/firewood			1
	General duties	Paying school fees			1
		Making phone calls	Short and long calls	talking on phone	2
		Plan	Plan my day programs		1
		Attending to evening duties			1
		Signing documents			1
		Daily duties			1
	Construction work	Cutting of poles for building house			1
		Building houses/shelter			1
Leasure, praying and education	Education	Going to school			1
		Studying			1
		Attending trainings			1
	Leasure	Little sleep (afternoon)	Taking an afternoon nap		1
		Listening to music			1
		Visiting friends			4
		Reading books			1
		Relaxing with friends	Meeting or talking to friends	Attending to visitors	3
		Resting			5
		Watching videos			1
		Dancing			1
		Singing songs			2
		watching news			1
		using the internet			1
		Taking a walk			1
		drinking alcohol			1
		Doing body exercise			2

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		Making use of entertainment			1
		Watching film			1
	Religious activities				
		Reading Bible			1
		Praying			8
		Going to church			2
Family care		Bathing children			1
		Preparing beds for children to sleep			1
		Teaching children			2
		Looking after children	Looking after baby		2
		Seeing the family	Sitting with the family	Spending time with the family	4
		Sending children to school			3
		Talking to family members			2
Community work		Community mobilization and sensitization			2
		Participation in meetings			5
		Sensitization of the community			1
		Mobilization of the community			1
		Attend to community issues	solving community issues	Identifying, discussing and addressing conflicts in the community	3
		Helping the community			1
		Giving feedback			1
		Writing of reports			1
		Contributing to community dialogues			1
		community outreach			1
		Participation in meetings with community leaders			1

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	Visiting sick persons and persons in need of help	1

Uganda: Challenges in the community

In the following we present an overview of challenges that the workshop participants stated. The activities were derived from dedicated questions during the workshop. The challenges were grouped and categorised as part of the evaluation. The categories were not predefined.

The identification of persisting challenges was a two-step process. Frist in an exploratory exercise all challenges that the workshop participants and their communities face were identified. This collection of challenges was consolidated after the exercise was completed. During the following workshop days, the consolidated list of challenges was presented, and participants were asked to priorities the individual challenges on the comprehensive list of challenges.

Participants were asked to select their individually perceived priority of the various challenges (not relevant, very low priority, low priority, medium priority, high priority, very high priority). To calculate a score, the following scoring system was used. The stated scores in the results file corresponds to the average score given by participants.

Scoring system:

- not relevant: 0
- very low priority: 1
- low priority: 2
- medium priority: 3
- high priority: 4
- very high priority: 5

It is important to note that the scores can only be viewed as an indication. The score should not be understood as robust.

Table 23: Overview of persisting challenges in the refugee and host communities in Bidibidi

Challenge with…	Description	Score
environment and climate	difficulties with dealing with the heat	3,7
	weather change / climate change: changing rain patters result in harvest losses	4,2
	deforestation: trees are being cut down (for firewood and charcoal)	4,4
	rocky ground discourages farming	4,2

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weather/ climate	at times there is shortage of rain	4,0
availability/ affordability of appliances, materials, and goods	e.g., tools for garden work	3,5
	high cost of construction materials/ natural resources, e.g., poles and grass	3,9
	lack of household materials	3,7
	affordability of goods such as tooth paste	1,4
agriculture	harvest losses due to limited rainfall	3,7
	high cost for renting agricultural land/ farmland/ land for digging	4,3
	crop disease/ sickness	3,8
	animals damaging crops	3,8
	limitations in the agricultural land available	3,9
	difficulty in acquiring/ renting agricultural land (shortage)	4,0
security	limited variety of food available due to drought	3,5
	theft (for example of life stook)	3,9
	vandalism at communal facilities, such as schools	3,1
entertainment	limited entertainment available (e.g., sport activities)	2,7
communication and connectivity	access to information (TV, radio, internet, etc.)	3,1
	insufficient network connection due to too few antennas	2,8
	limited access to information due to remoteness of community	3,2
	lack of smartphone and laptops	3,5
	lack of access to internet connection (e.g., at schools)	3,8
	megaphone is not available	3,4
water supply	shortage of/ insufficient water (no permanent source of water)/ scarcity of water	3,9
	too few water points	3,8
	long distances to reach water supply points	3,6
	insufficient water for farming (crops get dry)/ limitations in rainfall/ drought	4,5
	buying water for clothes	1,7
	lack of water supply at home	3,4
	water supply in communal facilities (e.g. schools)	3,9
livelihood, employment, and business opportunities	insufficient skills for food production	3,3
	sickness of animals bred	3,2
	difficulty in acquiring land for agriculture	4,2
	difficulties to find employment/ lack of employment	4,4
	a lot of competition in the existing business sectors	3,7
	lack centres for businesses	2,7
transportation	high cost of transport fares	3,5
	transport is not available or affordable (from home to garden, to visit friends), distances are long	3,8
	issues with fluctuation of price for fuel	4,0
	distances are long to reach farming land	4,3

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	long distance to the market	3,1
	long distance from home to schools	3,5
	difficulties of ensuring health services for those in need because of long distances	3,9
	distances are long to reach firewood	4,1
energy services and energy resources	lack of lighting at home	3,9
	lack of lighting at communal facilities (for examples schools)	3,7
	lack of lighting at night	4,0
	no lighting at night (impacts security)	3,6
	limited access to electricity to power gadgets, and machines (photocopies, computers, etc.)	4,1
	lunch is delayed due to shortage of firewood	4,2
	travelling long distances to collect firewood	4,5
	need for more mud stoves for cooking	3,8
	cookstoves are not sustainable	4,3
	buying wood to produce charcoal	4,1
	hard to get/ lack of firewood and charcoal	2,9
	lack of improved energy systems (e.g. cooker, solar)	4,8
infrastructure	vehicles passing by are loud	3,0
	broken bridges, roads in bad condition	2,1
	lack of shelters	4,2
food availability	availability and affordability of food/ lack of food in the community	4,1
	delays in food distribution	3,7
	refugees receive food portions according to "category"/ food log	4,2
financial constraints	continuous poverty	4,0
	no reliable income	4,2
	affordability of transportation	3,2
	affordability of school fees	3,6
	cost of living is too high	4,0
	not being able to by all desire items: e.g., food items like sugar for tea, charcoal, materials for farming	3,9
	price fluctuation of goods in the market	
sanitation system	lack of WASH facilities	3,5
	latrines can be full (at communal facilities like schools)	3,5
	access to sanitation facilities	3,1
	problems with sanitation system at home	3,3
staffing at communal facilities	e.g., schools	3,6
mobility	issues with moving at night	3,1
mobilization	Lack of batteries for megaphones	3,6
	lack of megaphones for mobilization	3,9

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social issues	misconception about gender issues	3,5
	language barriers in the community	3,4
	lack of commitment and cooperation in the community	3,2
	being under stress	3,7
	lack of parental care/ children are abandoned	3,8
	teenage pregnancy	4,3
	lack of knowledge of family planning	3,6
	lack of training particularly for women and girls	3,6
	low turn up at community meetings	3,7
	peer pressure	3,7
	no payment or motivation for leaders	4,3
conflicts	the community sometimes takes long to solve issues	3,1
	violence on the road (people getting beaten up)	2,6
	conflicts with neighbours	2,5
	conflict within the community	2,7
	conflicts at the water point	3,2
	conflicts within homes (among family members)	2,5
health	limited availability of insecticides	3,3
	lack of knowledge of disease prevention (for example malaria)	3,8
	drug abuse and alcoholism	4,4
	limited access to health services	3,6
	health issues like tiredness, loss of appetite	3,3
education	not enough trainings available	3,5
	children drop out from school	4,0
	lack of trainers and teachers	3,2
	lack of skills that enable business opportunities	3,6
	number of students in the class is too large	4,4
resettlement	resettlement of refugees in USA, EU, UK, etc.	3,2
time management	time management within the community	3,0
	lack of time to travel to home country	2,5

Uganda: Overview of energy services accessible in the communities, associated challenges and needs to overcome the challenges

In the following we present and overview of all energy services that participants stated as having access to. Prior to collecting all relevant energy services in the community, the workshop included several input sessions in which the group explored energy as a concept. The workshop was designed specifically to ensure that through the workshop all participants gained a basic understand of topics related to energy. This included the concept of energy services. Through the explorative exercise all available energy services were mapped, associated challenges were identified and needs to overcome the challenges were investigated. The categories shown in the table below were specified during the evaluation of the workshop results.

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The categories used to group the energy services are:

- Cooking and heating
- Lighting
- Appliances and livelihood
- Transport
- Communal facilities

Table 24: Overview of energy services that are accessible in the communities, associated challenges and potential means of overcoming challenges in the refugee and host communities of Bidibidi

	Energy service	Energy services accessed through technology and or energy source	Persisting challenges with energy services that are accessible	What is needed to overcome the challenge?	Frequ.
COOKING AND HEATING	cooking	firewood (includes using mud stoves and energy saving stoves)			14
			lack of firewood	Planting a lot of trees, encourage community to plant a lot of trees	1 117
			long distances to collect firewood		4
			health issues due to smoke	Alternative energy sources such as LPG	1
			issues with children getting burns when they play		1
			use of firewood causes chest pain and body weakness		1
			the level or amount of rainfall is reduced due to the excessive cutting of trees	Reforestation	3
				Encourage the community to plant tree and sensitisation of the community	1

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		Lack of strength to cut firewood because of lack of food (some go three days without food)		1
		Lack of knowledge on how to use mud stoves		1
			Sensitization on how to use mud stoves to reduce using very little firewood	1
		Lack of rainfall		1
		energy saving stoves sometimes have issues because of the materials used		1
	charcoal (includes mud stoves and energy saving stoves)			5
		charcoal is expensive		1
		charcoal stoves produce too much heat		1
		health issues due to smoke		1
		lack of availability of charcoal		1
		It emits carbon dioxide which spoils the ozone layer	planting of more trees to protect the ozone layer	1
		energy saving stoves sometimes have issues because of the materials used		1
	not specified			3
	kerosine			1
		kerosine is expensive		1
	biogas			1
	solar			2
		heat is low due to cloudy sky		1
heating or boiling water				6

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LIGHTING	lighting in homes	not specified			9
			lighting is not strong enough		1
			lack of lighting in homes	Search for long lasting system	3
			solar panels are too small		1
			solar systems are too expensive		1
		firewood			1
		solar			8
			lack of financial means		2
			many houses of not have lighting (darkness at night)		1
			lighting does not last long		1
	lighting of communal areas and facilities	solar			3
APPLIANCES AND LIVELIHOOD	using and charging phones	solar			19
			phones consume a lot of power		1
		power banks			2
	charging of tables, and speakers				1
	using radios	solar			4
			radios are very expensive to access		1
		dry cell			1
			many people do not have access to a radio		1
	playing music				2
	using electricity for appliances	not specified			1
			access to electricity is expensive	reduction of cost	1

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using printing, photocopying, computer services	generator			5
		too few photocopying machines are available and therefore the access to the service is limited		1
	not specified			3
using electricity to access the internet				1
		problems with the internet network		1
using electricity for information and communication				1
using fridge for cooling drinks and fruits				1
		power banks are not widely available	Provision of power banks for charging phones	1
	not specified	access to electricity is expensive	Providing different categories for electricity access	1
	generator			3
using appliances powered by dry cell batteries				1
using machines that run on diesel, such as grinding machines	diesel			3
		diesel is expensive	Establish stock when prices are low	1
operation of hair saloon	not specified			5
	solar			1

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	operation of sewing machines				1
			access to sewing machines is limited to few		1
			lack of knowledge of how to operate a sewing machine		1
	Drying of agricultural products (grass, cassava, maize, etc.)	utilizing the sun			4
	Access to electricity for businesses	solar			1
	using electricity for welding				1
	using electricity for tailoring services				1
	using electricity from hydropower				12
TRANSPORT	transportation	Fuel/petrol			8
			petrol is expensive	Establish stock when prices are low	1
	transportation of goods and food products				2
	transportation of people (motor vehicles and bikes)				2
COMMUNCAL FACILITIES	water supply	motorized (solar)			2
		not specified			4
			limited water points cause conflicts in the communities		1
			water supply is limited in the communities		1

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irrigation system	4
Space cooling at communal facilities	1
technical devices in health facilities	2

In extension to challenges associated with specific energy services, energy-related challenges not specific to an energy service and associated needs to overcome the challenges were identified. The challenges are presented in the following.

Table 25: Overview of general energy-related challenges and potential means of overcoming challenges in Bidibidi

Category	Persisting challenges with energy services that are accessible	What is needed to overcome the challenge?	Frequ.
COST AND FINANCIAL MEANS	high price of fuel		1
	energy services are expensive (affordability)		4
		Bring companies to sell solar systems at reduced and instalment price	1
	lack of financial means and poverty		5
		create employment opportunities for refugees	1
		introduction of support of micro-businesses for women	1
	Rising price of fuel		1
	low income		1
	solar systems are too expensive		1
	petrol and diesel are expensive		1
	accessing markets to sell drinks is difficult		1
ACCESS TO SERVICES, FUELS, AND PRODCUTS	only minority of persons in the communities have access to the energy services		1
	access to fuels for cooking is limited		1

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	machines are not available		1
	megaphones are not available		1
	transportation by motorbike is not available		1
TECHNOLOGY	devices are fragile (handling is difficult)		1
	solar panels are too small		1
	solar products: challenges with cloudy sky and rainy weather	Buying batteries which can store power	2
	solar system: when batteries have issues a repair is required		1
	issues with energy saving stoves (mud stoves) because of the materials used		1
	solar energy system: equip system with sufficient power		1
SAFETY	flammable fuels pose the risk of fires (grass thatched households can catch fire)		1
SKILLS	lack of technical know-how		1
	lack of skills and training		1
		Regular refresher trainings for the energy users	1
ENVIRONMENTAL	environmental challenges that result from cutting of trees for firewood without reforestation		1
	petrol and diesel pollute the air		1
	reliability of energy sources		1
INFRASTRCUTRE	transportation: poor road network		1
	communication: mobile network is unstable		1
STRCUTURAL AND POLITICAL	political challenges that prevent transition to renewable energies		1

Uganda: Energy access needs, access facilitators, and associated impact

In the following we present all energy services that participants stated as important to

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gain access to. The overview includes the technology through which the energy service need can be met, the facilities needed to enable access, and the associated impact of achieving access to the energy service.

The categories in the tables below were specified during the evaluation and match the categories for the overview of energy services that persons have access to.

Table 26: Overview of energy access needs, access facilitators, and associated impacts in the refugee and host community of Mahama

Category	Energy service	energy services accessed through technology and or energy source	What is needed to make the energy service available?	What would be the impact?	Frequ.
COOKING AND HEATING	Cooking				2
		Provide clean energy system for cooking		deforestation will be reduced	1
				reduce air pollution (Fossil fuel produce harmful particle that can contaminate the air and endanger human health)	1
		Better access to firewood			3
			planting of more trees		1
		Better access to charcoal			1
			planting of more trees		1
		Provision of alternative fuels for cooking (LPG, briquettes, pellets, biogas)			3
			income through income		1

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		generating activities		
			more environmental friendly	1
			reduced the time to cook	1
			reduced the risk of accidents	1
	using gas for cooking		gas has not many negative effects	1
			using gas saves time while cooking	1
			gas does not pollute the environment	1
	briquettes to be produced from biomass that is locally available			1
	cook stoves that use solar energy and that can charge devices			1
	modern cook stove ("energy stove")			4
	better access to mud stoves is needed	Training modern skills, sensitizing community about using mud stove, training facilitators to make stoves	it helps the community to reduce the firwood consumption	1
	alternatives means of cooking to prevent the cutting of trees			1
Heating of water in homes				1
Water heating for the community				1

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	Cooling of homes				1
LIGHTING	lighting of homes	Provision of solar lights to households			2
				improves the ability to study at home	1
	torches			improves lighting situation	1
	lighting				1
			Bring in permanent and sustainable lighting systems	Improved security in the community	1
				Bring in permanent and sustainable lighting systems	1
	public lighting				2
		Lighting of commercial area e.g. market, schools and health centres			2
	security lighting system				3
APPLIANCES AND LIVELIHOOD	phone charging	power banks for phone charging			1
	electricity				1
		access to electricity in business areas			2
		electricity from hydro power			1
		electricity from solar systems (with battery)			8
		power banks for charging devices			1
	using computers to learn and write				1

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	access to radios to community leaders				1
	access to computers				1
	access to scanning and printing				1
	access to sewing machines				1
	access to washing machines				1
	access to printing machines				1
	access to hair salon and barber				1
	charging of devices				1
	charging phones			improves ability to communicate	1
	ICT services		computers and accessories		1
			skills in ICT		1
TRANSPORT	public transport				2
		Public transportation for individuals long distance travel			1
COMMUNCAL FACILITIES	Irrigation system			Improvement in farming	4
	water pumping (into tanks)				3
	electrification of health centres				1

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In extension to needs associated with specific energy services, energy-related needs not specific to an energy service and associated needs to overcome the needs were identified. The needs are presented in the following.

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Table 27: Overview of needs to enable access to energy services and the respective impact in the refugee and host community of Bidibidi

Category	Persisting challenges with energy services that are accessible	What would be the impact?	frequency of answer given
General change	support for people in need		1
	change in the mindset of persons through sensitizing the community		1
Economic and business	provision of financial support		1
	Energy solutions imported should be at a fair price		1
	financial support to enable the purchase of energy services		1
	employment		2
	Introduce cash support groups to reduce income level problems	Change people's income level	1
	Improve business knowledge in the community		1
	Improve business opportunities, such as access to markets		1
	opportunities to earn income, e.g. by offering trainings to community members		1
	improve effectiveness of businesses		1
	access to startup capital		1
	access to markets		1
Exchange, trainings, communication and education	empowerment/trainings for community members		4
	Production of local energy resources (pellets, briquettes and biomass)		1
	enhance technical knowledge		1
	Provide trainings for sustainable systems		1
	Improve the access to education		1

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	Sensitisation of the community regarding the benefits of mud stoves, how to cook with md stoves and the benefits of utilizing of water pumps	1
	Conduct public meetings to explain about the opportunities and benefits of energy services at home	1
	trainers in the community	1
	communication about energy products, services and practices in the communities	1
	Enhanced emergency response and resilience	1
	Access to information on community scale energy initiatives	1
	Improved energy planning and decision support	1
	Improved energy literacy and engagements	1
Structural and political	Energy solutions to be produced locally in the communities	1
	Allow companies to bring some of their required items to produce the energy on the ground for easy access	1
	there is a need for regulations of solar products (likely this refers to the quality of the products)	1
	Stronger partnerships and collaborations	1
	Increased investment in energy infrastructure	1
	Renewable energy investments	1
	Enhanced emergency response and resilience	1
	Accelerated clean energy transition	1
Access to services, fuels, and products	Tools and resources to produce energy resources locally	1
	donation of energy products	1
	Services shall be near and accessible	1
Technology	making more technologies available	1
Safety and security	security to protect equipment	1
Environmental	planting of more trees	2
Infrastructure	land for housing the equipment	1

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	public announcement system (speakers)	1
Social	reduce laziness among the youth	1

Rwanda: Challenges in the communities

In the following we present an overview of challenges that the workshop participants stated. The activities were derived from dedicated questions during the workshop. The challenges were grouped and categorised as part of the evaluation. The categories were not predefined.

The identification of persisting challenges was a two-step process. Frist in an exploratory exercise all challenges that the workshop participants and their communities face were identified. This collection of challenges was consolidated after the exercise was completed. During the following workshop days, the consolidated list of challenges was presented, and participants were asked to priorities the individual challenges on the comprehensive list of challenges.

Participants were asked to select their individually perceived priority of the various challenges (not relevant, very low priority, low priority, medium priority, high priority, very high priority). To calculate a score, the following scoring system was used. The stated scores in the results file corresponds to the average score given by participants.

Scoring system:

- not relevant: 0
- very low priority: 1
- low priority: 2
- medium priority: 3
- high priority: 4
- very high priority: 5

It is important to note that the scores can only be viewed as an indication. The score should not be understood as robust.

Table 28: Overview of challenges in the refugee and host community of Mahama

Challenge with…	Description	Score
environment and climate	difficulties with dealing with the heat	3,7
	weather change / climate change: changing rain patters result in harvest losses	4,2
	deforestation: trees are being cut down (for firewood and charcoal)	4,4

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	rocky ground discourages farming	4,2
weather/ climate	at times there is shortage of rain	4,0
availability/ affordability of appliances, materials, and goods	e.g., tools for garden work	3,5
	high cost of construction materials/ natural resources, e.g., poles and grass	3,9
	lack of household materials	3,7
	affordability of goods such as tooth paste	1,4
agriculture	harvest losses due to limited rainfall	3,7
	high cost for renting agricultural land/ farm land/ land for digging	4,3
	crop disease/ sickness	3,8
	animals damaging crops	3,8
	limitations in the agricultural land available	3,9
	difficulty in acquiring/ renting agricultural land (shortage)	4,0
security	limited variety of food available due to drought	3,5
	theft (for example of life stook)	3,9
	vandalism at communal facilities, such as schools	3,1
entertainment	limited entertainment available (e.g., sport activities)	2,7
communication and connectivity	access to information (TV, radio, internet, etc.)	3,1
	insufficient network connection due to too few antennas	2,8
	limited access to information due to remoteness of community	3,2
	lack of smartphone and laptops	3,5
	lack of access to internet connection (e.g., at schools)	3,8
	megaphone is not available	3,4
water supply	shortage of/ insufficient water (no permanent source of water)/ scarcity of water	3,9
	too few water points	3,8
	long distances to reach water supply points	3,6
	insufficient water for farming (crops get dry)/ limitations in rainfall/ drought	4,5
	buying water for clothes	1,7
	lack of water supply at home	3,4
	water supply in communal facilities (e.g. schools)	3,9
livelihood, employment, and	insufficient skills for food production	3,3
	sickness of animals bred	3,2
	difficulty in acquiring land for agriculture	4,2

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business opportunities	difficulties to find employment/ lack of employment	4,4
	a lot of competition in the existing business sectors	3,7
	lack centres for businesses	2,7
transportation	high cost of transport fares	3,5
	transport is not available or affordable (from home to garden, to visit friends), distances are long	3,8
	issues with fluctuation of price for fuel	4,0
	distances are long to reach farming land	4,3
	long distance to the market	3,1
	long distance from home to schools	3,5
	difficulties of ensuring health services for those in need because of long distances	3,9
	distances are long to reach firewood	4,1
energy services and energy resources	lack of lighting at home	3,9
	lack of lighting at communal facilities (for examples schools=	3,7
	lack of lighting at night	4,0
	no lighting at night (impacts security)	3,6
	limited access to electricity to power gadgets, and machines (photocopies, computers, etc.)	4,1
	lunch is delayed due to shortage of firewood	4,2
	travelling long distances to collect firewood	4,5
	need for more mud stoves for cooking	3,8
	cookstoves are not sustainable	4,3
	buying wood to produce charcoal	4,1
	hard to get/ lack of firewood and charcoal	2,9
	lack of improved energy systems (e.g. cooker, solar)	4,8
infrastructure	vehicles passing by are loud	3,0
	broken bridges, roads in bad condition	2,1
	lack of shelters	4,2
food availability	availability and affordability of food/ lack of food in the community	4,1
	delays in food distribution	3,7
	refugees receive food portions according to "category"/ food log	4,2
financial constraints	continuous poverty	4,0
	no reliable income	4,2
	affordability of transportation	3,2
	affordability of school fees	3,6
	cost of living is too high	4,0

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	not being able to by all desire items: e.g., food items like sugar for tea, charcoal, materials for farming	3,9
	price fluctuation of goods in the market	3,7
sanitation system	lack of WASH facilities	3,5
	latrines can be full (at communal facilities like schools)	3,5
	access to sanitation facilities	3,1
	problems with sanitation system at home	3,3
staffing at communal facilities	e.g., schools	3,6
mobility	issues with moving at night	3,1
mobilization	Lack of batteries for megaphones	3,6
	lack of megaphones for mobilization	3,9
social issues	misconception about gender issues	3,5
	language barriers in the community	3,4
	lack of commitment and cooperation in the community	3,2
	being under stress	3,7
	lack of parental care/ children are abandoned	3,8
	teenage pregnancy	4,3
	lack of knowledge of family planning	3,6
	lack of training particularly for women and girls	3,6
	low turn up at community meetings	3,7
	peer pressure	3,7
	no payment or motivation for leaders	4,3
conflicts	the community sometimes takes long to solve issues	3,1
	violence on the road (people getting beaten up)	2,6
	conflicts with neighbours	2,5
	conflict within the community	2,7
	conflicts at the water point	3,2
	conflicts within homes (among family members)	2,5
health	limited availability of insecticides	3,3
	lack of knowledge of disease prevention (for example malaria)	3,8
	drug abuse and alcoholism	4,4
	limited access to health services	3,6
	health issues like tiredness, loss of appetite	3,3
education	not enough trainings available	3,5
	children drop out from school	4,0

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	lack of trainers and teachers	3,2
	lack of skills that enable business opportunities	3,6
	number of students in the class is too large	4,4
resettlement	resettlement of refugees in USA, EU, UK, etc.	3,2
time management	time management within the community	3,0
	lack of time to travel to home country	2,5

Rwanda: Overview of access to energy services accessible in the communities, associated challenges and needs to overcome the challenges

In the following we present and overview of all energy services that participants stated as having access to. Prior to collecting all relevant energy services in the community, the workshop included several input sessions in which the group explored energy as a concept. The workshop was designed specifically to ensure that through the workshop all participants gained a basic understand of topics related to energy. This included the concept of energy services. Through the explorative exercise all available energy services were mapped, associated challenges were identified and needs to overcome the challenges were investigated. The categories shown in the table below were specified during the evaluation of the workshop results.

The categories used to group the energy services are:

- Cooking and heating
- Lighting
- Appliances and livelihood
- Transport
- Communal facilities

Table 29: Overview of energy services that are accessible in the communities, associated challenges and potential means of overcoming challenges in the refugee and host communities of Mahama

Category	Energy service	Energy services accessed through technology and or energy source	Persisting challenges with energy services that are accessible	What is needed to overcome the challenge?	Frequ.
COOKING AND HEATING	cooking in the household				7
		not specified			2
			not specified		1

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			access to modern cooking solutions, such as improved cookstoves	1
			enhance access to cooking fuels other than firewood	3
			there is a need for energy in which does not damage the environment, e.g. LPG	1
			enhance access to cooking materials and energy products for cooking	2
		lack of fuel for cooking		2
		challenges with cooking		1
	LPG			4
		buying LPG is expensive	improve affordability of LPG	2
		provided LDG supply is insufficient		2
			access to sufficient LPG	1
			removal of categories in supply of gas and fuel additives	1
		difficulties of transporting the LPG cylinder		1
		challenges with accessing LPG	enhance access to LPG	2
	charcoal			4
		cooking with charcoal takes a long time, hence other activities are affected		1
		burying firewood is prohibited		1

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			challenges with accessing charcoal	enhance access to charcoal	1
			charcoal is expensive		1
		firewood			6
			burying firewood is prohibited		2
			insufficient access to firewood	support in accessing fuels that are not firewood	2
			there are no forests		2
			insufficient access to firewood due to government policies		2
			use of firewood is challenging for persons with disability		1
			firewood is expensive		1
			because of a lack of access to firewood, biomass waste (e.g. grass) is used, which is less efficient		1
					136
	heating water (for drinking, washing etc.)				0
		not specified			4
		firewood			1
		LPG			2
	lighting				4
		not specified			3
LIGHTING			in households without sufficient lighting		1
			children struggle to study		
			poor lighting can strain eyesight and potentially lead to other health problems.		1

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		household lighting (SHS)			6
			Power of SHS is limited and does not allow for charging of a phone	access to SHS that have a higher power	1
			SHS is sized too small, which limits its use		2
			insufficient lighting in the home		0
			unable to repair or pay for repairments of damaged solar system		1
			in winter the services provided by SHS are reduced		1
			duration of lighting is limited and is insufficient to fulfil needs		1
	outside lighting				0
		not specified			2
		torch			2
		phone			2
		solar lantern			1
	public lighting				2
			insufficient lighting on the street	enhance lighting of the streets	1
	lighting for a business				2
APPLIANCES AND LIVELIHOOD	Listening to the radio				5
			the radio can only be used when it is connected to the power bank. The capacity of the power bank is limited and therefore also the time listening to the radio		1
			not having a battery prohibits the use of a radio		2
			lack of access to electricity prohibits use of radio	enhance access to electricity	1

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using a phone (communication and paying for services)				9	
		lack of network because there are too few towers	it is necessary to build more communication towers	1	
charging a phone				2	
	not specified			3	
		access to electricity to charge phones is limited	enhance access to electricity to charge phones	2	
		at times the is no electricity to charge phones		1	
		challenges with charging the phone		1	
		not owning a solar panel		1	
	solar			1	
charging power bank				1	138
		power bank does not allow charging of phone and radio at the same time		1	
charging of devices				1	
playing music				2	
watching TV				1	
		TV can not be operated because of a lack of electricity		1	
Cooling and Freezing of				1	
	fridge and freezer for cooling or freezing fruits, vegetables and animal products (e.g., milk)			2	

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		challenges with accessing cooling and freezing services		1	
	fridge for cooling water and drinks			1	
	fan			2	
		no access to a fan to reduce the heat		1	
electricity				0	
	not specified			4	
		many locations are without electricity		1	
		insufficient access to electricity	enhance access to electricity (ensure it reaches everyone)	8	
		insufficient power		1	
		frequent power outages		1	
		lack of financial means to afford electricity		1	
		at times there is no electricity to charge phones		1	139
	solar panels			2	
		challenges with accessing electricity from solar panels	better access to solar panels	2	
	SHS			0	
		batteries of some SHS are damaged and can not be used	access to maintenances services	1	
		SHS does not support the operation of businesses (e.g. hair salon)		1	
		SHS are too small to meet energy needs		1	
	grid	no access to the grid	access to the grid should be extended from the host community to the refugee communities	1	

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using electrical devices				1	
		challenges with using electrical devices		1	
		lack of electrical devices because of the high cost	decrease the price of electrical devices	1	
pressing of clothes	flat iron			1	
ironing of clothes				0	
	not specified			2	
		challenges with ironing		1	
	charcoal iron			2	
		burning and spoiling of clothes due to use of charcoal iron		1	
		use of charcoal is damaging the environment	access to electrical ironing prevents environmental degradation	1	
using the internet				1	
		most of the time financial means are not sufficient to buy data (lack of money)		1	140
			enhance availability of internet services	2	
sewing	sewing machine			1	
shaving				1	
Drying (e.g., beans, sorghum, maize, soja, groundnut)	utilizing the sun			3	
		during the rainy season there are challenges with drying using the sun		1	
washing clothes	utilizing water and the sun			2	

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			during the rainy season there are challenges with drying using the sun		1
	operation of machines for production processes				1
	electricity for the operation off a business				1
			challenges with accessing electricity for business use		1
	using photocopying services				1
	using laptops (e.g. for payment services)				1
TRANSPORT	transportation of persons and goods				2
		motorcycle or boda-boda (petrol)			3
			prices for petrol have increase		0
			because the price of fuel is high, transportation fees are expensive		1
		bus			1
COMMUNCAL FACILITIES	water supply				0
		motorized	access to water is insufficient		3
				enhance the supply of pumped water supply	1
				build tanks to store the rain water	1

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	water irrigation system		0
		water sprayer and tank	1

In extension to challenges associated with specific energy services, energy-related challenges not specific to an energy service and associated needs to overcome the challenges were identified. The challenges are presented in the following.

Table 30: Overview of general energy-related challenges and potential means of overcoming challenges in Mahama

Category	Persisting challenges with energy services that are accessible	What is needed to overcome the challenge?	frequency of answer given
ECONOMIC	inability to pay for energy services		1
		enhance opportunities for employment	1
	inability to pay for repair services		1
		enhance opportunities for employment	1
	prices of items have increase, including food, fuel and petrol		1
	affordability of electricity and services that require electricity	there is a need for sponsors to support financially	1
SERVICES	issues with accessing water/ water supply is insufficient		1
	insufficient access to energy services	support in accessing energy services	1
BUSINESS	access to stronger SHS allows for the operation of businesses (e.g. hair salon)		1
	lack of opportunities to operate a business	support in developing business ideas	1
	lack of funds to start businesses	there is a need for sponsors to support financially and provide capital for businesses	1

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EDUACTION	students struggle with homework (due to a lack of light), hindering their learning and potentially leading to lower grades or dropping out of school.	1
	Student repeat in the class because they do not have electricity to use while doing their homework/ studies	1
SAFETY AND SECURITY	Darkness creates an environment where children are more susceptible to violence and exploitation, including sex abuse and prostitution.	1
GENERAL WELLBEING	lack of equipment, infrastructure and services tailored to the needs of disabled persons (e.g. bathrooms for disabled persons)	1
TECHNCIAL	Introduction of batteries can help with more reliable supply of electricity, especially in the rainy season	1

Rwanda: Energy access needs, access facilitators, and associated impact

In the following we present all energy services that participants stated as important to gain access to. The overview includes the technology through which the energy service need can be met, the facilities needed to enable access, and the associated impact of achieving access to the energy service.

The categories in the tables below were specified during the evaluation and match the categories for the overview of energy services that persons have access to.

Table 31: Energy access needs, access facilitators, and associated impact in the refugee and host

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Category	Energy service	energy services accessed through technology and or energy source	What is needed to make the energy service available?	What would be the impact?	Frequ.
COOKING AND HEATING	cooking				0
		not stated	reduction in the fuel cost		1
		alternative to firewood			2
				cooking with firewood takes a lot of time	1
				burning wood causes stress	1
		improved cookstoves			2
				reduce the environmental impact (climate change)	1
					144
		grid	access to the electrical grid	electrical cooking will reduce the time spent cooking	1
		LPG	improved access to LPG		2
				cooking with LPG makes cooking easier and makes the food taste better	1
				overcome challenges resulting from lack of firewood	1
				protection of the environment	1
		electrical			1
LIGHTING	Lighting for households				2
		solar	access to solar lighting	enables children to study at night	1
		SHS			1

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			SHS in household	enables children to study at night	1
	Lighting for communal areas				2
			enhanced lighting in communal areas	enables children to study	1
	Public lighting (streetlights)				0
			enhanced public lighting	supports businesses	1
APPLIANCES AND LIVELIHOOD	Electricity				0
		not specified (access to electricity)			4
			access to the grid		1
		solar panels			2
		SHS			145
					0
			access to SHS	enables businesses	1
		power banks for mobile phones			1
		batteries and access to electricity to charge them			2
	Charging of phones				2
			access to phone charging	phone can be used for many different things	1
	Cooling and Freezing				0
		not specified			5
				fridges can be used for businesses	1
		fridge for cooling of drinks		fruits and vegetable can be stored for a longer time	3
		fridge or freezer for cooling or freezing food			7

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		access to the service	ability to keep food for longer	4
			avoid losses for restaurants	1
			keep the original flavour of the food for longer	1
		support by organisations in acquiring or getting access	prevent fruits, vegetables, and other food from spoiling	2
			the ability to cool food would allow buying food for lower prices	1
		support for persons with disabilities (limited mobility) to get access to cooling for food	food can be bought in larger quantities and therefore less trips for buying food are needed	1
				146
			There are issues with food getting stolen from disabled persons who let other people buy for them. Buying larger quantities reduces the theft	1
	fridge or freezer for cooling or freezing agricultural produce (fruit, mil, meat, etc.)			1
	fan for cooling in households			1
enhanced access to electricity				2
			improvements in students performance	1

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electricity				1
	SHS with increase power			1
	operation of electrical devices (lighting at home, phone charging, shaving, etc.) using SHS			1
	using electrical devices	lack of financial means to buy electrical devices		1
listing to the radio				2
drying	electrical			1
washing	electrical			1
running a hair salon				1
	SHS	SHS that are large enough to support the operation of the required devices		1
watching TV	educational shows on TV for children			147 3
			Educational shows can help them learn about various subjects and stay up-to-date on current events.	1
			education and entertainment for children	1
	TV for adults			3
			Staying informed through news programs	2
			opportunities for education	1
			enhance entertainment	1
use an egg incubator				1

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	using processing and production machine				2
		milling		ability to produce flour	3
		oil extraction		ability to produce oil	0
		post-harvest processes			1
		drying			1
	tailoring and sewing				2
	hair salon and barber shops				3
			hair salon business required electricity		1
		shaving machine			1
	printing and photocopy services				2
	washing clothes				1
		using a laundry machine			1
	computer				3
			access to computers	improvements in students performance	1
				access to news	1
				enhances individual development	1
			trainings on how to use computers		2
	technology to improve education				1
TRANSPORT	transport				1
COMMUNAL FACIL	water pumps				1

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		improve water supply infrastructure	1

In extension to needs associated with specific energy services, energy-related needs not specific to an energy service and associated needs to overcome the needs were identified. The needs are presented in the following.

Table 32: Overview of needs to enable access to energy services and the respective impact in the refugee and host communities of Mahama

Category	What is needed to make the energy service available?	What would be the impact?	Frequ.
GENERAL NEEDS	Persons with disabilities require additional support, including financial support		1
ECONOMIC	Financial support		7
	employment		2
	support to start small businesses	economic development	1
	improved financial capacity	enables persons to buy equipment, and products and pay for services	7
		employment increases self-sufficiency, as it enables starting a business and buying equipment	1
	reduction in prices of products		1
	economic development		1
TECHNICAL	access to the electrical grid		1
	increase the availability of different types of energy and making them accessible		1
	improve access to energy services by making them available in close proximity		1

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ADVOCACY	advocacy is required to increase financial means of persons, as access to energy services required money	2
	advocacy to improve access to energy services	1
	advocacy to address challenges	1
EDUCATION AND SKILLS	trainings about energy and skills to be able to use electrical appliances	6
	Trainings	3
BUSINESS	support from organisations to achieve access to agricultural machines and machines for businesses (e.g. egg incubator, drying machines, etc.	1
	enhanced entrepreneurship	1

Further outputs

The workshops were designed in line with Participatory Action Research (PAR) principles, emphasizing mutual learning, co-production of knowledge, and a bi-directional exchange between the research team and the participants. For the research team, the workshops facilitated in-depth insights into locally perceived challenges and the role of energy in everyday practices. For the participants, the workshops served not only as a space to share experiences but also as an opportunity for capacity building through interactive input sessions and collaborative reflection. In keeping with the PAR objective of generating outcomes that extend beyond data collection, we also developed tailored handouts to support participants' continued engagement with the discussed topics. These handouts are included in the report as Annex 1 and Annex 2.

3.2. Results: Context survey

The context survey generated a large and highly structured quantitative evidence base, including extensive tabulations and disaggregated comparisons across population groups. To maintain readability in the main deliverable, the detailed survey results are therefore presented in two separate stand-alone results reports—one for Uganda and one for Rwanda—which accompany Deliverable D1.1. Presenting the survey findings in separate reports makes it easier for readers to (i) navigate the results without overloading the main document, (ii) use each country report as a self-contained reference for national and site-specific evidence, and (iii) access the full set of tables

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and subgroup analyses when needed for detailed interpretation and follow-up work.

Across both country reports (with identical structure to enable comparison), the results are organised to move from general household context to increasingly specific insights on energy services. The first results block, Demographics and household context, provides the baseline characteristics needed to interpret differences across groups and sites (e.g., household composition, gender and age structure, socio-economic conditions, and other contextual variables used for disaggregation). The second block, Role of energy in daily lives, links energy access to everyday life by summarising how households describe wellbeing-related aspects (e.g., sources of joy, key challenges, and perceived priorities) and by highlighting where energy-related constraints intersect with broader livelihood and wellbeing conditions.

The third and largest block presents energy-service-specific findings, covering Cooking, Lighting, Street lighting, Electricity, and Community services. Each energy-service section follows a comparable internal logic to ensure consistency across services and between the two country contexts. Typically, the sections begin with a short framing of what the service means in daily life and then document: (i) preconditions for access, such as responsibility patterns, knowledge/awareness, and perceived availability of technologies or services; (ii) current access and usage patterns, including the technologies used, frequency and purpose of use, and typical access pathways; (iii) expenditure and affordability dimensions where relevant (e.g., recurring costs, purchasing patterns, and constraints related to limited financial means); and (iv) persisting challenges and enabling factors, such as safety concerns, reliability, quality of service, maintenance/repair issues, and the role of support structures or service providers. Throughout, results are presented in a way that facilitates comparisons between refugee and host communities and highlights relevant differences across socio-demographic groups where the data allow.

Finally, both country reports include a complementary results section that additional breakdowns to support interpretation (e.g., further disaggregation, cross-tabulations, or supporting indicators). Overall, the two stand-alone results reports provide the detailed quantitative evidence base, while the present main deliverable offers the overarching narrative and the structural overview of how the survey findings are organised and should be read alongside the other person-centred components documented in this chapter.

4. Literature

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V. ENVIRONMENTAL ANALYSIS – RESOURCE POTENTIALS AND CIRCULARITY

As outlined in the overall methodology, the contextual analysis under Task T1.1 is organized into four complementary components that together build a comprehensive understanding of the demonstration contexts in Rwanda and Uganda. This chapter documents the environmental analysis component. It focuses on resource potentials and circularity-relevant conditions that shape the feasibility and sustainability of energy interventions, including the availability and characteristics of local resources and the implications for circular approaches. The chapter therefore provides an environmental baseline that complements the system-centred description and the person-centred analysis, and it supports the interpretation of opportunities and constraints for implementation within the wider methodological framework described in Chapter III (Overall methodology).

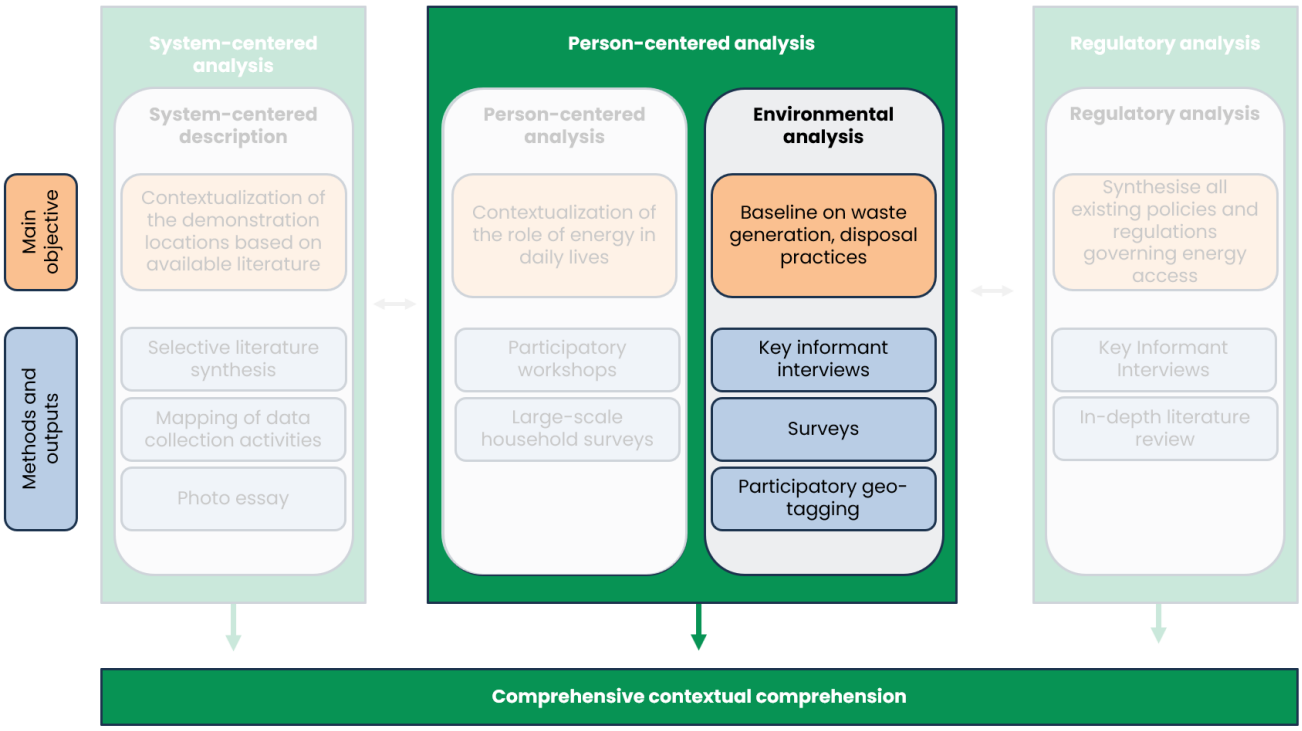

Figure 50: Environmental analysis as part is one component in the overall methodology.

1. Introduction and Objective

SWM and Biowaste in Bidibidi Refugee Settlement. The Bidibidi Settlement hosts around 250,000 refugees and continues to face major challenges related to waste handling,

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limited collection of services, unsafe disposal practices, and lack of recycling infrastructure. Most inhabitants rely on open dumping and burning, which heightens environmental and health risks. Yet, biowaste represents a significant portion of the waste generated locally and holds potential as a resource. The study identified key biowaste sources (households, farms, schools, and health facilities) and examined existing reuse practices such as composting and animal feeding. While dispersed populations and low waste volumes limit large-scale valorisation, concentrated waste sources offer opportunities for biogas production and composting, reducing environmental pressures and supporting circular livelihood models. These findings point toward the potential for integrated SWM systems linking sanitation, energy generation, and sustainable resource use in both refugee and host communities.

Research Objectives. The analysis aimed to enhance understanding of organic waste generation and management in Bidibidi and host communities, assess current disposal and valorisation practices, and determine the potential for biowaste collection and processing for energy production. These findings provide an environmental baseline to inform SUNNY's circularity and sustainable energy interventions.

2. Methods

The adopted methodologies followed the overarching SUNNY project framework, combining person-centred and system-centred analyses to integrate both social and technical dimensions of waste management. Data collection tools included a structured questionnaire, key informant interviews (KIIs), and geotagging of waste production, management, and disposal sites. While the research covered various waste types, this report focuses on findings related to biowaste.

Five research assistants (RAs) conducted fieldwork: four from CTEN, a refugee-led South Sudanese association, and one from Makerere University (UMAK) under the supervision of Prof. Michael Lubwama. RAs received training from ReFuse's environmental expert on solid waste management to ensure methodological alignment. Research approval was obtained from the Office of the Prime Minister (OPM) in Kampala and local authorities in Yumbe District. Field access was coordinated with settlement zone and village leaders to ensure community participation and compliance with local governance protocols.

Person-Centred Analysis: A person-centred approach was applied to assess the perceptions, practices, and challenges of refugee and host communities concerning waste management. A semi-structured questionnaire of 14 questions was designed to explore waste generation, disposal habits, repair and reuse practices, and related environmental or health issues. Data collection was supported by CTEN members fluent in local languages, who translated questions and responses to ensure clear

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communication. Participation was voluntary and based on informed consent, with strict adherence to privacy and ethical standards. Responses were digitally recorded using a custom Appsheet tool, which allowed secure entry, tracking, and anonymization through coded identifiers. The dataset is available to SUNNY consortium partners, with ownership retained by ReFuse.

System-Centred Analysis: The system-centred analysis assessed waste management value chains within the broader legal, environmental, social, and technological systems. Three methods were employed:

- Literature Review – Synthesizing existing scientific, policy, humanitarian sources.
- Key Informant Interviews (KII) – Conducted with officials, NGOs, business owners, informal waste workers to assess waste generation, collection, recycling gaps.
- Geotagging and Co-Mapping – Using Appsheet's GPS-enabled interface to identify and record waste producers, service providers, and disposal sites through community-guided mapping.

Mapping exercises supported spatial understanding of waste flows and served as an initial participatory step toward future planning and intervention design.
Four data sources were used throughout the analysis: [LIT] Literature research; [SSQ] Semi-structured questionnaire; [KII] Key informant interviews; [MAP] Geotagging and co-mapping. These datasets form a factual basis for subsequent analyses and discussions in the report.

3. Results

The field activity was kicked-off with a training on integrated solid waste management for the data collection team and by conducting visits to villages, markets, government offices, landfills, schools, businesses and more. Data collection began in October 2024 and was completed with the final data entries at the end of November 2024. RAs noted observations and interviews in the dedicated mobile application built on AppSheet, along with the answers to KIIs registered in writing.

Person-Centred Analysis Sampling. Through random sampling, a total of 105 individuals were interviewed using the SSQ throughout the five zones of the settlement and the host community within. Gender diversity, age representation, belonging to both the refugee and host community and a spatial distribution were the key driving factors to verify the representation of interviewees. Data collection included both female and male respondents, provided they were over 18 years old, with only one individual per household permitted to complete the questionnaire. Illiteracy did not pose a barrier to participation, as the interviews and questionnaires were conducted orally. The gender

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representation is relevantly equivalent, women (55) and men (50). Respondents questioned belonged to the host community (42), and refugee community (63). As expected, people below 35 years old were met the most, seeing the population distribution within the area, with a high percentage of young inhabitants (UNHCR, 2022). The number of individuals interviewed per zone was defined based on the corresponding population size, for example, zone 3 hosts +58,000, the highest of them all, and was allotted 15 interviews.

Spatial representation was paramount as clusters of households can be over 20 km apart and have different biophysical characteristics, for example in terms of agricultural suitability and water availability (JEU, 2019) meaning that different living conditions can be encountered. Considering a population of 246,294 refugees - as per UNHCR's latest published statistics (UNHCR, 2022) - a total of 60 interviews was planned to obtain a 10% margin error, with a 90% confidence level that the sample accurately reflects the attitudes of the sample being analyzed. The margin of error indicates the extent to which the results of a survey reflect the actual views of the population as a whole. Surveys conducted by organizations like the UN or World Bank often target a 95% confidence level and work with smaller margins of error (between 5-7%). Research with lower confidence levels (like 90%) is considered acceptable for exploratory or preliminary studies (Fink, 2017).

Bidibidi hosts 33% of the total population living in Yumbe district - mainly Aringa Ugandans living in the surrounding areas. 580,000 local inhabitants live within the 2400 km2 district (UNHCR, 2018). Bidibidi is scattered in a 780 km2 territory including host communities within refugee populated areas (JEU, 2019). A proportional population was therefore calculated as an approximation to set a number of host community respondents: 40 individuals were set as a target and 42 people were met.

Person-Centred Analysis Results. Data resulting from SSQs is presented. Free listing replies were categorized by the team aggregating similar responses. The survey started with researching purchasing behaviours, to have an understanding of how consumption patterns change within different communities, possibly influencing different disposal patterns. Question Q1 “Which are the things you purchase the most?” provided an overview of respondents’ cash spendings. Basic subsistence products such as greens, vegetables, beans, peanuts were the most mentioned by both communities. A higher response rate was provided for sugar by host communities, while refugee respondents appear to spend more on books, paper, clothes and shoes. Seen the similar distributions, the question does not highlight a significantly different spending habit. The analysis was run also per zone, aiming to assess differences within the settlement. No significant variation is observed, yet refugees living in zone 2 appear to recognize spending more on products with potentially higher costs as shoes, clothes, soap, books, while refugees

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in zones 1, 3, 5 have a higher reliance on basic food items with lower costs (WFP, 2023).

Question Q2 "Which are the things you throw away the most?" highlighted a high presence of biodegradable waste within the mix of materials disposed of by both refugees and host communities. The analysis shows the number of responses recorded disaggregated per status, showing that local Ugandan inhabitants provide similar replies to displaced people living in the settlement, possibly highlighting similar waste production patterns. Comparing purchased and disposed organic, biodegradable items, it is possible to observe how a high presence of food leftovers, green waste composes the organic waste mix of both refugee and host communities. A gender-based perspective appears when analysing answers to Q3 "What do you think waste is?". Men provided higher response rates defining waste as something already used, not useful, not wanted or important, without value, that is not good to consume. Women, instead, had a stronger negative perception of waste, defining it as something dirty or bad, or something that can cause health problems.

Respondents were requested to define the difference between dry waste and bio waste in Q4. Very different answers were provided mostly defining dry waste as something that can be burned, and bio waste as something that smells, gets rotten and decomposes. Limited answers were provided defining both as things related to health issues or unpleasant living conditions. Dry waste was seen by some respondents as something manufactured, as opposite to something natural as bio waste. The usability of waste as a resource does not significantly differentiate the definition of dry waste and bio waste: for both, limited answers presenting alternatives for reuse, recovery were presented. Q5 "What do you do with your bio/organic waste?" provided an understanding of the most recognized, adopted practices in the refugee and host communities. The analysis shows that most community members dispose of what they consider to be bio waste in rubbish pits. Open burning, dumping in random sites or in latrines appear as minor practices. Bio waste reuse habits of around 40% of respondents include using this source as animal feeding or for producing "Manure", the term used to refer to compost, material to be used in agriculture.

Respondents' knowledge on bio waste reuse was tested through Q6 "What are ways to use bio waste or transform it into a resource?". Answers mostly referred to the same practices observed for Q5, with around 50% of recorded replies mentioning compost production and animal feeding. Few respondents suggested other reuse practices such as mixing it with soil for fertility (similar to "manure" production), mulching, producing briquettes or biogas, and fermenting bio waste to produce alcohol. A significant number of responses highlighted no way to reuse bio waste or no knowledge about it. Host

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communities appear to be more aware about composting, refugee communities provided more answers on other disposal practices. To align answers, RAs shared a definition of solid waste with respondents, considering waste as items that you no longer need or that you do not want and you get rid of as garbage. Q7 “How do you dispose of other waste?” was analysed to observe potential differences in behaviours based on gender, status. Open burning and rubbish pits were mostly mentioned, reflecting literature information on disposal methods. No significant variations were observed differentiating male and female respondents. A minor difference can be noticed by disaggregating by status, with a higher percentage of refugee respondents referring to rubbish pits and some forms of source sorting.

Waste valorisation practices were investigated through "Q8: How could these things be of use instead?”. Most respondents did not know ways to make use of waste. Few respondents suggested refilling plastic containers, building fences, structures or minor items as key chains. 24 responses suggested selling valuable items and recycling.
Waste valorisation practices were investigated through "Q8: How could these things be of use instead?”. Most respondents did not know ways to make use of waste. Few respondents suggested refilling plastic containers, building fences, structures or minor items as key chains. 24 responses suggested selling valuable items and recycling. The SSQ further investigates on the perceived negative externalities of waste and on the potential for reuse, repair trading items and materials. The latter won’t be presented as they do not refer to the research scope of this paper. Through Q9 and Q10, participants were requested to list problems that could affect them and their communities. After two questions investigating positive externalities, the aim was assessing which concerns are associated with waste. These questions do not provide insights on if and how waste related problems are significantly impacting the community. No comparison was made with any other aspect. The team agreed that understanding which problems affect the community the most, and assessing if waste is a key concern would have not added valuable information without spending a significant amount of time through different open ended questions. Waste related problems perceived do not present significant differences at community or personal level. Most respondents recognize how waste can increase the exposure of diseases, including cholera and malaria. They recognize the potential to favour insect breeding, and to cause other health issues such as infections, skin rashes, vomiting, diarrhoea. Waste does not only create discomfort, bad smell and unpleasant living conditions. It directly contributes to damaging soil fertility and pollution in general. At a personal level, injuries represent a minor externality. At a community level, 4 respondents mentioned that waste can result in tensions or conflicts.
A list of 8 challenges was presented before the only close-ended question, Q10, where respondents were requested to prioritize negative externalities identified through literature: animal breeding, release of gasses, fire risk, health hazard, pollution, flooding, increased tensions and evictions. Evictions and fires appeared to be the least

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concerning issues followed by clogging of water channels resulting in floods. Other risks were almost equally perceived as concern factors, with no significant variations disaggregating by gender, status.

Key Informant Interviews

RAs and the environmental expert led the research on waste management systems. The team conducted 45 KIIs, meeting representatives of local authorities such as the Yumbe District Environment Officer or the Office of the Prime Minister Commander for the settlement. Refugee representatives were also interviewed, both during SSQ and KII. Two farmers were directly engaged in KIIs, on top of the ones individually met through surveys. School and Health Centre representatives were met to gain an understanding on their waste production and disposal practices. Humanitarian organizations, including international non-governmental organizations and United Nations agencies were interviewed to understand successes and failures of relevant interventions. Several private service providers - small scale enterprises dealing with solid waste - were involved, and informal waste workers (collector, traders) were interviewed. Three industrial recycling facilities outside of the settlement have been visited. As mentioned in the methodology, KIIs were not structured due to the diversity and unpredictability of respondents engaged. A detailed analysis is therefore not presented, and results will be used and quoted within the discussion. Most recurrent topics recorded during KIIs include: Environmental policies; Biowaste management; Recycling; Repair services; Solid and liquid waste disposal.

Geotagging and Co-mapping

The geotagging exercise allowed mapping sources of waste and resources flows through the recommendations of community members met and informants interviewed. The exercise allowed better understanding how refuse is generated from different Waste Producers , some of which generate higher ratios of organic waste (farms, food processing units, market areas). Several service providers dealing with solid residues were met to assess how dry, bio waste are handled within the scope area, and to understand the engagement of the (informal) private sector in solid waste handling. Limited service providers directly deal with biodegradable matters, while most service providers met work with scrap plastics, metals, electronics to trade materials or provide repair services. Disposal sites were recorded to assess categories of waste gathered, handling practices, aiming to compare field observations with literature data. Several pits where solid waste is accumulated, disposed and sometimes burned were recorded, observing the presence of very diverse materials including recyclable materials (paper, cardboard, LDPE, HDPE, PET), organic matter (particularly peels, banana stems) and

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other matters including recurring elements as textile waste, diapers.

4. Discussion and implications for the SUNNY project

Bio waste produced in the target area

Field visits, KIIs, SSQ resulted in an improved understanding of biowaste flows in Bidibidi Settlement and in the surrounding area. Different streams of biowaste were directly observed visiting disposal sites, meeting individuals in their households, and getting to know local businesses, facilities and projects. Four categories of biowaste were identified: 1) Household and cooking biowaste; 2) Livestock biowaste; 3) Agricultural biowaste; 4) Human biowaste. A non-quantitative infographic of biowaste flows is presented, including different biomasses, 4 categories of biowaste, and three different end of life solutions (figure 13). Household and cooking biowaste is the organic biomass found both in households and places where food is prepared, including schools and health centres. Such biomass includes peels of cassava, maize, vegetables and greens, shells of peanuts and beans, egg shells, fish and meat bones (in very low volumes compared to others), spoiled food, leftovers and ashes from wood, charcoal [LIT, MAP, SSQ, KII]. Livestock waste was found in non-significant amounts next to households who own few animals for personal consumption [MAP]. Larger volumes of livestock biowaste were found in cow farms and pigs farms [MAP]. In such farms, the higher production of biowaste was observed where animals were kept within fences, particularly for pigs breeding, yet concentrated volumes of animal manure were hard to find as most cattle is raised in open spaces, grazing freely [KII, MAP]. Agricultural biowaste was not observed in large amounts due to the season.

In fact, as field visits were conducted at the beginning of the rainy season, several farmers, households were restarting crops, tilling and seeding [KII, MAP]. Streams of agricultural biowaste presented by respondents, observed included peels, leaves and highly fibrous stems of cassava plants; sweet potato vines and leaves; rice husks and straws; highly fibrous banana stems and leaves; shells, vines and stalks of beans and groundnuts; vegetable stems and ruined, rotten vegetables; cobs, stalks and husks of maize; sorghum stalks, husks, leaves; pods, leaves and stems from okra fields. Human biowaste was a significant concern for local authorities, representatives, schools, health facilities [KII]. The need for costly desludging operations was reported in different interviews, and different types of latrines were observed. Some respondents mentioned that pits are closed once filled, while others resort to desludging trucks [KII, MAP]. Two wastewater treatment facilities where human waste is treated were observed within Bidibidi and in the Yumbe Municipality.

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Bio waste producers identified

Different producers of biowaste are categorized and presented in Table 6 to discuss which sources could be relevant for bio waste valorisation interventions. Key producers of bio waste identified include: Clusters of households with their subsistence crops; Farmers and agricultural producers; Small-scale livestock producers; Kitchens of schools and health-centres; Clustered latrine pits. For each, opportunities for reuse and concerns are discussed, based on field observations, collected data and literature. Through literature, a quantitative estimation is provided, aiming to facilitate the design and sizing of valorisation initiatives. Table 6 presents each bio waste producer, providing details with a clear reference to the different sources of information chosen.

Table 33: Comparative analysis of biowaste producers, presenting waste generated, opportunities for reuse vs concerns.

Biowaste producer	Opportunities for reuse	Concerns for reuse
Clusters of households, subsistence crops	Within clusters of households, biowaste production can reach 0.26 kg per person per day [LIT: Coelho et al., 2020; Komakech et al., 2014; Jain et al., 2022], and subsistence farming can generate valuable inputs for valorisation [KII, MAP]. A cluster of 30 families with seven members each [LIT: WFP, 2023] can generate 50 kg per day. The rural context ensures the presence of green waste around households from subsistence crops. As per land use observations, subsistence farming extends to an average of 0.2 hectares/person [LIT: FAO, 2023].	Seasonality strongly affects bio waste production [LIT: Komakech et al., 2014]. In the dry season, green waste from subsistence crops is limited. Higher volumes of biomass are generated when harvesting, peeling produce as cassava, yet production is concentrated in a few days per year [KII, MAP]. High presence of soil, sand in biowaste was observed [MAP]. Participatory engagement and awareness raising are required due to the limited experience of individuals [SSQ]. Bio waste is often used for animal feeding, compost production.
Farmers, agricultural producers	The high reliance on agriculture makes bio waste available where crops are raised. Seasonality strongly influences productions, with 3-6-12 months agricultural cycles observed depending on crops [MAP, KII]. Stems, leaves, peels are produced for different products. In rural Uganda, farms extend to less than 1 hectare [LIT: UBOS, 2020]. Cropland extends to	Distance of crops from households, particularly in zones with rocky soils as in Zone 3, makes bio waste hardly accessible [KII]. Seasonality strongly affects bio waste production [LIT: Komakech et al., 2014]. In the dry season, green waste from crops is limited. Higher volumes of biomass are generated when harvesting, peeling produce, yet production is

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	25% of the settlement [LIT: Nakalembe et al., 2022]. Through regionalized datasets, bio residues can be estimated. For instance, agricultural bio waste generated amounts to 4.28 t/ha/year for cassava plantations; 0.61 t/ha/year for groundnut crops; 2.48 t/ha/year of husks can be gathered from maize fields and 2.56t/ha/year from rice plantations discarding straws [LIT: FAO, 2014].	concentrated in a few days per year [KII, MAP]. High presence of soil, sand in biowaste was observed [MAP]. Bio waste is often used for animal feeding, compost production, construction [SSQ].
Small-scale livestock producers	Pig and some cattle farms generate higher volumes of manure where animals are kept in restricted areas. Manure's high nutrient content makes it valuable for reuse [KII, LIT: Drosg et al., 2013]. Depending on the number of heads, their daily feeding (stable, grazing), regional parameters, respectively a production of up to 2.67, 0.59, 0.33 kg of volatile solids per cow, pig, goat per day are generated [LIT: Owusu & Banda, 2017].	Where animals are fed through open grazing, bio waste production is scattered and waste collection is more difficult [KII, MAP]. During the dry season, waste production is lower [KII]. Large farms, stables were not observed during field visits.
Kitchens of schools, health centres	Kitchens, canteens produce a relatively constant stream of bio waste with similar composition throughout the year [KII, MAP]. Presence of both raw, cooked food waste. Eased source sorting due to limited diversity of materials used. Eased awareness due to limited staff engaged [KII, MAP]. Seeing the diversity of cooking systems observed, dietary plans conditioned by funding, no numeric estimate is given for bio waste generation [KII, MAP].	Volumes are small as most schools, health centres do not provide meals to all students, yet only to paying learners [KII]. High presence of soil on peels and significant presence of highly fibrous materials as large banana stems [MAP].
Clustered latrine pits, wastewater treatment units	Clustered latrines with 3-4 toilets are commonly found in schools, health centres and store concentrated human waste rich in nutrients [KII, MAP, LIT: Drosg et al., 2013]. Ventilated	Dry toilets are commonly used resulting in low humidity rates of biomass. Human waste has sanitation concerns due to disease vectors breeding, particularly for water borne diseases

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	improved pits daily store biowaste depending on the number of users. Reuse of human waste biomass observed after proper composting, curing, possibly confirming positive perception on reuse [KII, MAP]. Bio waste produced can be easily estimated knowing the number of latrine users - recommended at 45 persons per latrine by humanitarian standards [KII, LIT: Sphere, 2019]. Excreta includes from 300 to 500 L/person/year of urine and 50 L/person/year of fecal matter with 80% humidity rate [LIT: EAWAG, 2014]. Two wastewater treatment facilities were observed in Bidibidi (not operational), Yumbe (actively managed), with concentrated bio waste delivered by desludging trucks [KII, MAP].	[MAP, KII, LIT: EAWAG, 2014]. High smell, operating concerns, contamination risks in case of improper handling. Desludging operations are hardly affordable for individuals and pose a significant pressure on humanitarian organisations [KII], making transportation of bio waste difficult.

Bio waste disposal and treatment. The methods observed confirm literature data on habits and practices. Bio waste is found together with mixed waste in dug pits or in open piles of waste next to households, market areas [MAP]. Sometimes bio waste is disposed of in latrines [KII, SSQ]. Solid waste is not collected within Bidibidi Settlement and is only partly collected with a truck operated by a driver and two collectors within Yumbe Municipality [KII]. The collection system does not reach host communities visited around the settlement. Natural degradation of the organic matter in pits or on soil and open burning are therefore the main practices observed. Sanitary treatment was only observed for human waste collected with desludging trucks, mainly financed by humanitarian organizations [KII]. Primary, secondary and tertiary treatments are guaranteed for human excreta, sludge gathered in the wastewater treatment plan in Yumbe, while the wastewater treatment facility built in Bidibidi is not operational as confirmed during field visits and interviews with refugee representatives [MAP, KII]. Therefore, bio waste disposal remains a significant concern, seeing the negative externalities it causes, which are largely recognized by both refugees and their hosts [SSQ, LIT: JEU,2019]. Weak awareness, governance, law enforcement, follow-up systems make bio waste sanitary management more complex [SSQ, LIT: JEU,2019].

Bio waste reuse and valorisation. Simple bio waste valorisation practices are largely

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adopted by both refugee and host communities, as confirmed through SSQ. The key methods of reuse are discussed presenting waste categories diverted from disposal, the processing method. Biomass is mostly recovered for reusing it as feedstock for animals and producing compost. Fermentation for alcohol production was reported during SSQ, but not observed on the field. Experiences in anaerobic digestion were not found in Bidibidi.

Table 34: Comparative table of observed methods of reuse

Methods of reuse	Bio waste categories	Description
Feeding for livestock	Household, cooking bio waste; Agricultural bio waste	Community members commonly dispose of organic waste next to their households, throwing organic remains to pigs, cows, hens [KII, SSQ].
Composting for reuse in agriculture	Household, cooking bio waste; Agricultural bio waste; Livestock bio waste; Human waste.	Several KII, SSQ confirm that bio waste is transformed into soil amendment through aerobic digestion. Despite the rudimental, non sanitary digestion process, compost production is well known across the area and implemented by some farmers transforming household, agricultural, livestock bio waste into what they refer to as "*manure*" [KII]. Compost for farming is also produced after the dehydration of sludge, ensuring a long curing, sanitation phase [KII].
Briquettes making for energy usage	Household, cooking bio waste; Agricultural bio waste; Livestock bio waste	Briquettes were produced by different initiatives using different alternatives to charcoal dust. Green waste, grass, cut-offs, peels were used to produce briquettes for household use. Bio waste was mixed with binding agents as clay or cassava flour. In some cases, pre-treatment at high temperatures was performed. Initiatives were financed by humanitarian organisations, yet all interventions observed stopped due to lack of financial resources, non- entrepreneurial operations and difficulties operating with large groups of scattered beneficiaries [KII].
Fermentation for alcohol making	Household, cooking bio waste; Agricultural bio waste	Fermentation of bio scraps is reportedly adopted for the production of alcohol at household level [SSQ], yet the method was not directly observed and volumes of bio waste are not considered relevant.

Valorisation of Bio Waste for Biogas Production. Anaerobic digestion of bio waste for

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biogas production is an established natural, technological solution for both sanitation and energy production. Anaerobic Digestion (AD) is defined as a microbial degradation of organic material in the absence of oxygen. Usually, the process takes place in a reactor called a digester, which can greatly vary in shapes. During the AD process, biogas is generated and accumulates in a gas storage tank. This gas mainly contains methane (~ 60%), carbon dioxide (~ 40%) and some other constituent gases though in smaller quantities. Methane is the component of biogas that is combustible and as such is a potential fuel for cooking, heating, lighting and electricity generation. Biogas can be generated from a wide range of organic materials which among others is solid organic waste (Mugagga & Chamdimba, 2021). Biogas is an energy source that can be implemented to address the energy needs of refugee settlements. Implementation of AD technologies helps mitigating Green- House Gas (GHG) emissions and reach sustainable development goal 7 (SDG 7) "Ensure access to affordable, reliable, sustainable and modern energy for all" (Mugagga & Chamdimba, 2021; Chowdhury et al., 2022). Yet, constraints to the applicability, cost-efficiency of biogas digesters exist, and will be discussed through a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis combining literature review with gathered data.

Diverse systems have been piloted, tested in humanitarian settings and refugee settlements, adopting different technological solutions, transforming diverse biomass streams and targeting bio waste producers of different scales. Three scales will be confronted, based on key informant interviews with the leading refugee authority UNHCR and on literature review:

- Household Digesters (Micro-scale): These systems are designed for individual households, processing small amounts of organic waste to meet domestic energy needs. Common types include fixed-dome and floating-drum digesters. They are characterized by their simplicity, low cost, and suitability for rural or low-income settings [KII, LIT: ISAT, 2010].
- Cluster Digesters (Medium-scale): Serving small communities, farms, or businesses, these digesters handle larger volumes of organic material, such as agricultural residues or manure. They often require more sophisticated designs and management compared to household systems. Medium-sized upright concrete digesters are commonly used in this category [KII, LIT: Fischer et al., 2002].
- Wastewater Treatment Digesters (Large-Scale): made for municipal or industrial wastewater treatment facilities, these large-scale digesters process substantial quantities of sewage sludge or industrial effluents. They are complex systems designed for high efficiency and energy production, often integrated into broader waste management and energy recovery infrastructures [KII, LIT: Amigun & von Blottnitz, 2010].

A TOWS analysis is chosen to easily display Threats, Opportunities, Weaknesses and

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Strengths of the three different digesters. The analysis is a broadly adopted, simple matrix which helps to better formulate and design business interventions (Kulshrestha & Puri, 2017), in this case the piloting of a biogas production unit.

Table 35: Threats (T), Opportunities (O), Weaknesses (W), Strengths (S) of setting-up Micro-, Medium-, Large-scale digesters in Bidibidi Settlement and Yumbe District, Uganda

	Household Digesters (Micro-scale)	Cluster Digesters (Medium-scale)	Wastewater Treatment Digesters (Large-scale)
T	•Gas usage for cooking is minimal and awareness is low in Bidibidi. Gas stoves are scarce in the market and supply is not reliable in rural Uganda (U-LEARN, 2022). •Upfront investments for ready- made digesters is highly disproportionate to the average household expenditure [KII, LIT: Nevzorova, 2019]. •Food waste, garden residues result in low biogas yields [KII].	•Bio waste suppliers vs biogas users ratio is low: bio waste from a large number of households suffices the needs of a restricted group, affecting commitment to source feedstock, uptake [KII]. •Usage of biogas from low-tech digesters is limited by low pressurization, narrowing burning to distances below 200 meters, possibly affecting viability if the waste source is not next to facilities in need of biogas. Biogas transportation in sacks is costly, inefficient [KII]. •Experiences of biodigestion of food waste, green waste from cooking units failed due to low system yields [KII].	•Wastewater treatment facilities present in Bidibidi, Yumbe heavily rely on international financial support, risking service interruption in case of funds disruption [MAP, KII]. •Wastewater treatment facilities in the district rely on gravity-led water flows and have low energy needs. Biodigestion would produce gas far from locations with energy needs [MAP, KII].
O	•Home-digesters have very low operating costs: almost all expenses are upfront while running expenses are almost absent (Nevzorova, 2019). •Gas usage for cooking increases household interest, technology uptake [KII].	•In Bidibidi, Yumbe concentrated sources of bio waste are present in small farms, restaurants, schools (despite their limited waste production). These also have high energy demands, favoring uptake [KII, MAP]. •Interest can be driven by significant lack, inaccessibility of energy sources in Bidibidi, Yumbe (U-LEARN, 2022). •The agricultural nature of the region can favor uptake due to interest in liquid effluents for	•Co-digestion of different bio-waste streams is possible, seen the high humidity rate

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		fertilization [KII].	
W	•Home-digesters for low-income, rural households lack a significant, stable bio waste source [KII]. •Appropriate humidity ratio and system maintenance may require extra water, making viability lower in dry seasons, sites [KII].	•Regular operating needs make technology follow-up less likely if no clear financial benefit is obtained from biogas and digestate usage [KII]. •Maintenance needs (mainly for sludge removal) can lead to non-productive periods, affecting digesters built for cost-recovery purposes [KII]. •Gas storage in batches, bags is complex, difficult to handle [KII].	•Technical infrastructure is required, and dedicated trained staff is essential, yet such facilities are more suitable in densely populated areas [KII]. •Maintenance needs require significant efforts, particularly in case of digestor clearing where restarting operations takes time, and might require bacteria inoculation [KII].
S	•Higher income, clustered households can count on diverse bio waste streams (including subsistence farming waste) for co-digestion, with relevant bio-gas generation potential [KII, SSQ, MAP].	•The anaerobic digestion of animal waste supports sanitation efforts with low operating costs. Bio waste digestion is an effective approach if environmental protection is the primary objective [KII].	•Wastewater collected through desludging trucks is homogeneous, and has high biogas potential [KII]. •Biodigestion contributes to primary or secondary wastewater treatment, with pathogens and solids reduction [KII].

The negative externalities of waste mismanagement are widely perceived by refugee and host communities living in the Bidibidi Refugee Settlement and in the surrounding areas in the Yumbe District. Open burning and unsafe disposal in non-controlled rubbish pits without any collection service directly affects people's right to a standard of living adequate for the health and well-being of themselves and of their relatives. Biowaste is a significant component of solid waste daily produced by this community living in a rural setting and often relying on subsistence farming. Key producers of bio waste include: Clusters of households, subsistence crops; Farmers, agricultural producers; Small-scale livestock producers; Kitchens of schools, health centres; Clustered latrine pits, units for wastewater treatment. These sources generate diverse bio waste streams that were clustered into four main categories: 1) Household and cooking biowaste; 2) Livestock biowaste; 3) Agricultural biowaste; 4) Human biowaste. Waste generation and management was studied based on field observations, key informant interviews, semi-structured questionnaires and literature review. The study provided insights on volumes of waste produced to support the design of future interventions. Bio waste production in

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this region is limited, and several common practices divert this matter from being disposed of. Bio waste is commonly used as feeding for livestock and is transformed into a compost like output for reuse in agriculture. Few other practices such as briquettes making for energy usage and fermentation of edible discards were also observed. The scattered distribution of people living in the research area, coupled with low waste production in general and existing reuse practices result in limited opportunities for bio waste valorisation. Significant efforts would be required to gather small amounts of organic waste in a not densely populated rural setting. For this reason, initiatives that aim to transform bio waste into a resource should focus on concentrated sources of bio waste, where a stable supply is present and where the outputs of the valorisation process are directly used and adopted. The adoption of biogas technology in Bidibidi and Yumbe faces multiple challenges, primarily due to limited awareness, unreliable gas supply, and high upfront investment costs for ready-made digesters. The scarcity of gas stoves, coupled with the lack of a stable bio-waste source for home digesters, restricts household-level adoption. Additionally, low biogas yields from food and garden waste, as well as inefficient transportation methods, hinder the viability of biogas as a reliable energy source. While biogas could potentially contribute to sanitation efforts and environmental protection, its uptake is further constrained by maintenance challenges, seasonal water availability, and the need for technical expertise. Wastewater treatment facilities, though present, depend heavily on international funding, making them vulnerable to financial disruptions. Despite these barriers, opportunities for biogas adoption exist, particularly in institutions such as schools, farms, and restaurants, which generate concentrated bio-waste and have high energy demands. The agricultural nature of the region could also drive interest in bio digestion due to the value of liquid effluents as fertilizers. Co-digestion of different bio-waste streams, including subsistence farming waste, has the potential to improve gas yields, especially in higher-income, clustered households. Additionally, wastewater collected through desludging trucks presents a promising avenue for biogas production. However, for biogas to be a viable alternative energy source, significant investment in infrastructure, maintenance, and training is required, particularly where centralized treatment systems are in place.

5. Summary and outlook

Waste mismanagement affects both refugee and host communities undermining their right to well-being. With some 250,000 refugees in the Bidibidi Settlement, the Yumbe District faces significant challenges in providing waste handling services. Resorting to indiscriminate dumping and open burning is a daily practice for most. Theoretically, bio waste valorisation represents an opportunity for sanitation and livelihood creation. Yet, proven successes and systemic data on bio waste in the region lack. A system- and a person-centred analysis were adopted to provide information on the categories of bio

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waste produced in BidiBidi Refugee Settlement and in its surrounding host communities. Through semi-structured questionnaires, key informant interviews, field assessments and literature review, information on the current methods of bio waste disposal is provided, presenting how clusters of households, subsistence crops farmers and agricultural producers, small-scale livestock producers, kitchens of schools and health centres, clustered latrine pits, wastewater treatment units generate diverse bio waste streams. Existing reuse practices and disposal habits are discussed, and a focus on the potential to transform bio waste into an energy source through anaerobic digestion is discussed, presenting Threats, Opportunities, Weaknesses and Strengths of three different scales of digestors.

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VI. REGULATORY AND POLICY ANALYSIS

As outlined in the overall methodology, the contextual analysis under Task T1.1 is organized into four complementary components that together build a comprehensive understanding of the demonstration contexts in Rwanda and Uganda. This chapter documents the regulatory and policy analysis component of the deliverable (see Figure 51). It examines the national and local policy and regulatory landscape relevant to energy interventions in humanitarian and rural access-to-energy contexts, with particular attention to differences between host communities and refugee settings. By identifying key frameworks, institutional responsibilities, and procedural requirements, the chapter supports the assessment of feasibility and enabling conditions for SUNNY solutions and complements the market screening and subsequent development of policy recommendations.

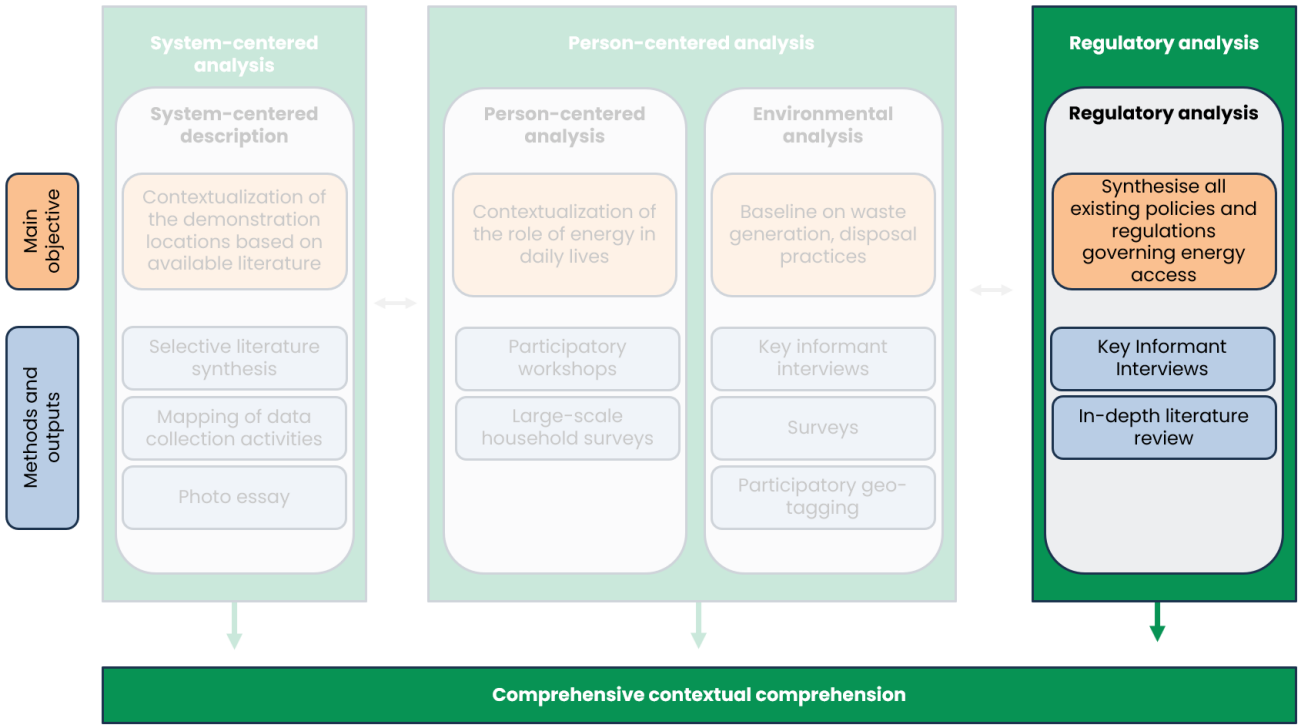

Figure 51: Regulatory analysis as part is one component in the overall methodology.

1. Introduction and Objective

The analysis of regulatory and policy conditions aims to develop a comprehensive overview of the regulatory and policy frameworks shaping energy provision in displacement contexts through combining an extensive desk review with expert interviews at both national and settlement levels. Through gaining a detailed

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understanding of existing policies and regulations on energy access as well as the integration of refugee populations, barriers and opportunities for advancing sustainable and inclusive energy access for displaced populations and host communities will be identified. The results of the analysis will facilitate the implementation of forthcoming SUNNY activities and inform evidence-based policy recommendations for refugee contexts by contributing to two subsequent WPs, and specifically to D6.4 Policy Recommendations and D7.4 Market Assessment.

The objectives of this sub-task are twofold:

1. To compile and synthesize all existing international, national, regional, and humanitarian policies and regulations governing energy access in displacement contexts in Rwanda and Uganda.
2. To analyse how these policies and regulations influence the provision and accessibility of energy in displacement contexts in Bidibidi (Uganda) and Mahama (Rwanda).

The research will address three main research questions:

1. How do national-level policies and regulations shape the provision of energy access in displacement contexts?
2. What gaps exist within the current policy and regulatory frameworks governing energy access in displacement contexts?
3. Which bottom-up or informal processes fill these gaps?

2. Methods

This section outlines the methodological approach applied in the regulatory and policy analysis and explains how the evidence base for this chapter was developed. The analysis combines two complementary components: semi-structured interviews with national-level stakeholders in Rwanda and Uganda, and a comprehensive desk review of relevant policy, regulatory, and institutional documents. Accordingly, the section first presents the overall methodological logic of the chapter and then describes each of these two components in more detail. This structure also provides the basis for the presentation of results, which distinguishes between findings from the key-informant interviews and findings from the desk review.

2.1. Overall Methodology

As a first step, the research team conducted a review of academic and grey literature on regulatory and policy frameworks in displacement contexts. The review highlighted that, to date, no comprehensive assessment of policies and regulations on energy provision in displacement contexts has been carried out for Rwanda or Uganda. However, it identified several promising lines of inquiry of value to both academic

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research and policy development, including an overview of the different types of policies and how these intersect within the displacement context (UNITAR & GPA, 2022), literature on the tensions between humanitarian and development policy approaches (Rosenberg-Jansen, 2019, 2025), and governance approaches to scaling sustainable energy services for displaced people (Grafham et al., 2022; Perros et al., 2022). Building on these insights, TUB developed a methodology and workflow which guided the data collection on the regulatory and policy environment (T1.1.2)

The developed methodology is made up of two key components, comprising interviews with key informants from Rwanda and Uganda (Part A) and a comprehensive desk review of all relevant policies and regulations (Part B). The data collection was carried out collaboratively by TUB, HUD, PA, TE, and E2050. More details on each of the components is provided in the table below:

Table 36: Overall Methodology of the regulatory and policy analysis

Method	Partner	Details
A. Interviews with national-level stakeholders	TUB	Expert interviews with stakeholders from the government, NGOs and international development partners - Six interviews in Rwanda - Six interviews in Uganda
B. Comprehensive Desk Review	TE E2050	Present a comprehensive overview of all context-relevant policies and regulations governing, and synthesize the existing relevant literature

2.2. Methodology: Semi-structured interviews

The research team conducted a total of 12 semi-structured interviews via Zoom, including 6 with stakeholders from Rwanda and 6 with stakeholders from Uganda, which lasted between one and one and a half hours. The sampling strategy of stakeholders ensured the inclusion of diverse perspectives, ranging from non-profit organizations working in refugee contexts to governmental actors involved in policy formulations. A comprehensive overview of interviewees can be found in the table below (Table 37).

Table 37: Overview of key-informant interviews conducted as part of the regulatory and policy analysis

Country	**Code**	**Date**	**Type of stakeholder**
Uganda	UG01	October	Bilaterial development partner, settlement-based
Uganda	UG02	October	NGO
Uganda	UG03	October	Bilaterial development partner, head office
Uganda	UG04	November	Humanitarian organization

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Uganda	UG05	November	International development organization
Uganda	UG06	December	International development organization
Rwanda	RW01	October	Bilateral development partner
Rwanda	RW02	October	NGO
Rwanda	RW03	November	Humanitarian organization
Rwanda	RW04	November	NGO, camp-based
Rwanda	RW05	November	International development organization
Rwanda	RW06	December	NGO

The interviews were structured around four thematic areas, but also created space for an iterative process, throughout which relevant emerging insights were explored. Overall, issues that were discussed included stakeholder roles in energy provision, the national policies and regulations that most directly influence such initiatives, and the enabling and constraining factors within Uganda's and Rwanda's regulatory environment. Participants were also invited to reflect on how policies operate in practice compared to their official intent, and to share strategies used to navigate policy challenges. The discussions also address inclusivity and equity, exploring how existing frameworks support energy access for refugees and host communities and how they respond to the needs of women, youth, and persons with disabilities.

All interviews were, with permission, recorded and transcribed using the software 'Trint'. Subsequently, NVivo was used to carry out an iterative, qualitative coding process to uncover the structural and contextual dimensions of energy provision in displacement contexts. An initial set of deductive codes was established based on the literature review, the project's research questions, and the themes identified in the interview guidelines. This preliminary coding framework was later refined through additional inductive categories to account for new insights that emerged. This iterative process allowed the analysis to remain open to the complexity of real-world experiences while preserving analytical consistency.

2.3. Methodology: Comprehensive desk review

The desk review formed the second component of the regulatory and policy analysis and was designed to provide a structured assessment of the policy, regulatory, and institutional environment shaping energy access in displacement contexts in Rwanda and Uganda. Building on an initial review of academic and grey literature, the desk review focused on collecting and synthesising relevant global, humanitarian, regional, and national policy and regulatory documents with direct or indirect relevance to energy access in refugee settings and surrounding host communities. The review covered both policies affecting the five SUNNY technology areas and broader regulatory frameworks relevant to larger-scale energy systems, such as grid extension and mini-grids. The analysis was carried out from a regulatory, policy, and institutional

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perspective and did not assess market demand, affordability, willingness to pay, or financial viability, as these aspects are addressed in WP7.

Methodologically, the desk review combined two steps. First, a structured overview of key frameworks was compiled, prioritising those policy and regulatory instruments considered most relevant to energy access in displacement contexts in Rwanda and Uganda. This overview served as a reference framework for the subsequent analysis and included information on the level of the framework, the responsible actor, the date, and the reference source; while not exhaustive, it was designed to capture the frameworks most pertinent to the objectives of the subtask and was complemented by references to external policy and legal databases to improve completeness and transparency. Second, the identified documents and the wider literature were analysed comparatively across the two demonstration countries in order to: (I) trace the evolution of relevant policies and regulations over roughly the past two decades, (ii) identify enabling factors and persisting gaps affecting sustainable and inclusive energy provision in displacement contexts, and (iii) examine the regulatory conditions shaping market-based approaches to energy access.

3. Results: Key informant interviews

This section presents the findings from the key-informant interviews and outlines how stakeholders in Uganda and Rwanda perceive the policy and regulatory conditions shaping energy provision in displacement contexts. It highlights key actors, relevant policy and regulatory frameworks, and the main enabling and constraining factors affecting implementation in practice. The section is structured into a short introduction followed by separate presentations of the findings for Uganda and Rwanda.

3.1. Introduction

This deliverable examines the governance of energy provision in displacement contexts in Uganda and Rwanda, with a particular focus on how policies, institutions, and implementation practices shape energy access for refugees and host communities. Drawing on semi-structured interviews with national and local stakeholders, as well as a review of policy documents, it explores the interaction between humanitarian, development, and environmental frameworks across multiple governance scales, with a focus on the overlap between refugee contexts and host communities.

For Uganda, the findings highlight a central tension within the displacement-energy nexus: whilst the country has developed a comparatively progressive and inclusive policy landscape - exemplified by initiatives such as the Sustainable Energy Response

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Plan (SERP) and commitments under the Comprehensive Refugee Response Framework (CRRF) - the translation of these ambitions into practice remains uneven. By analysing gaps between policy design and on-the-ground realities, the deliverable identifies structural, institutional, and financial barriers that continue to constrain equitable and sustainable energy access in refugee-hosting areas.

The Rwanda case study shows that energy access gaps persist where refugee settings are only partially integrated into national policy frameworks. National energy provision in displacement contexts is shaped primarily by environmental protection concerns rather than by a rights- or welfare-based approach to refugee energy access. While the government does not block NGO or private-sector engagement, refugees remain largely excluded from national electrification plans, subsidy schemes, and clean energy financing mechanisms, reinforcing reliance on humanitarian actors. Furthermore, the interviews highlighted that fragmented collaboration between actors, affordability gaps and regulatory barriers create a structural disconnect between Rwanda's national energy goals and energy access realities in refugee camps.

The sections below examine these findings for the Ugandan and Rwandan context, and formulate key recommendations on the basis of the analysis.

3.2. Findings for Uganda

Uganda's policy approach to refugee integration is widely recognized as progressive and inclusive (Grafham et al., 2022; UNHCR, 2021; UNITAR & GPA, 2022). However, the findings of this study reveal significant gaps between policy ambition and implementation when it comes to the provision of energy services in displacement contexts. While national regulations provide a strong foundation, and efforts to implement these policies are evident across sectors, their effectiveness is undermined by limited resources and enforcement capacity amongst both governmental and non-governmental stakeholders. The interviews further showed that increasing pressure on land, natural resources, and public services risks exacerbating tensions between refugee and host communities, which leads to questions around how Uganda's integrated approach to hosting refugees will develop in the coming years.

Governance

As illustrated in Figure 52**Error! Reference source not found.**, the governance of energy provision in displacement contexts in Uganda is shaped by multi-layered arrangements involving three key stakeholder groups - governmental agencies, UNHCR and other implementing partners, such as development partners and NGOS. While national ministries set the overarching policy framework and district governments are responsible for local implementation, UNHCR functions as a central gatekeeper in

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refugee settings, mediating access, coordinating actors, and approving interventions. In addition to these stakeholders identified by (Grafham et al., 2022), the interview respondents identified two further stakeholders that are involved in governing processes, namely district governments and refugee leadership. The analysis exposed that the governance processes are shaped by highly unequal roles and decision-making power, which become evident when studying how governance is decentralized in Uganda.

Figure 6. Humanitarian energy policy landscape in Uganda, prior to the Sustainable Energy Refugee Response Plan (SERP)

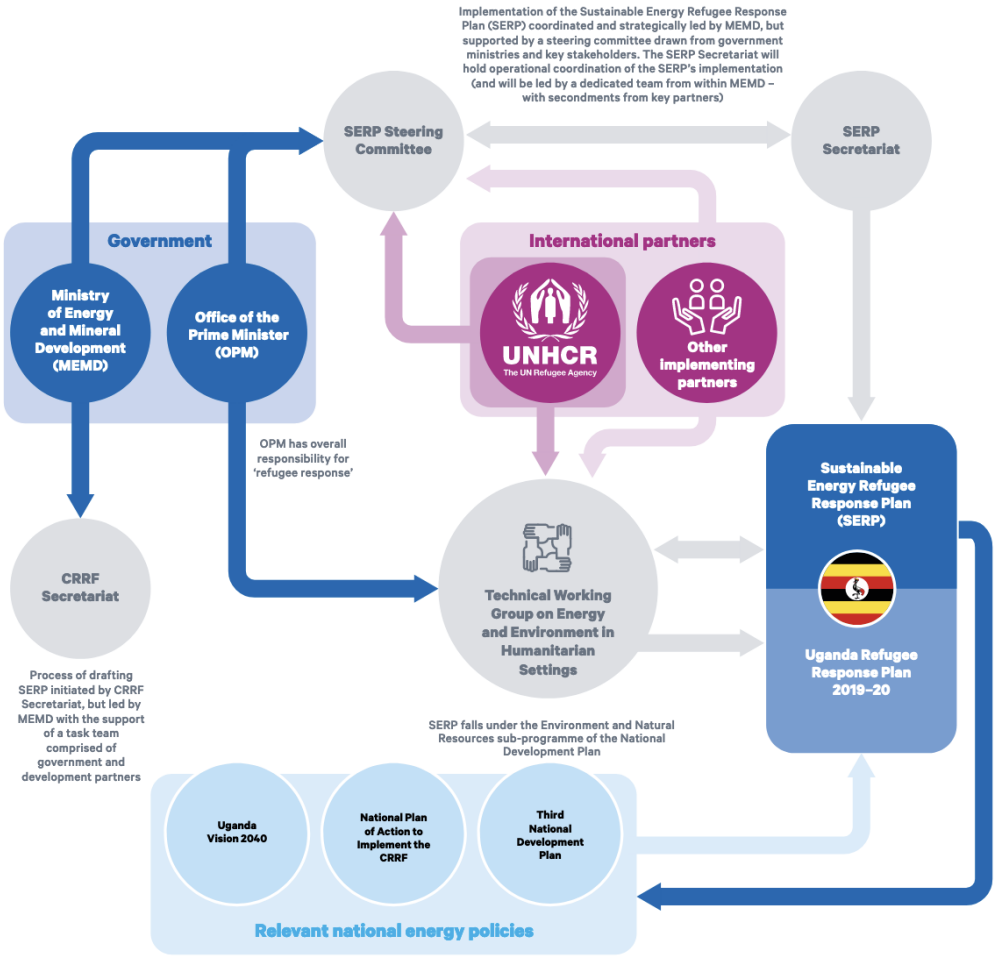

Figure 52: Policy landscape in Uganda, Source: Grafham et al., 2022

The importance of decentralization

The primary challenge in Uganda lies not in policy design, but in translating existing frameworks into equitable outcomes within highly diverse regional contexts. District governments emerge as critical yet under-resourced actors in this process, tasked with implementing and enforcing national policies - such as those governing wetland and forest protection – whilst considering the context-specific challenges of their region. For

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instance, this includes Uganda's differing land tenure systems, particularly between communal land ownership in northern regions and predominantly government-owned land in the south, leading to different issues for refugees in terms of how they access land (UG02). Moreover, the effectiveness of well-designed policies is significantly constrained by affordability gaps, which affect both refugee and host populations and result in a limited uptake of clean energy solutions.

In addition, refugee representation in Uganda has been institutionalized through a decentralized leadership system that mirrors the country's local governance framework. At settlement level, refugees elect Refugee Welfare Committees (RWCs), organised hierarchically from RWC1 at the village level through to RWC3 at the settlement level, closely resembling Uganda's Local Council (LC) system from LC1 to LC3.
At national level, the Refugee Engagement Forum (REF) is a higher-level representation mechanism that brings together leaders from RWCs to ensure systematic participation of refugees in national refugee response coordination, as ratified in the CRRF (Dzuy-Tâm Trân & Marijke Deleo, 2021).

Having refugee representatives at multiple levels plays an important role in the governance of resource access in Uganda, particularly by creating formal channels for dialogue between refugees, host communities, and state actors. As one stakeholder (UG02) explained, platforms such as the Refugee Engagement Forum (REF) bring together refugee representatives with the Office of the Prime Minister (OPM), UNHCR, and host community representatives, providing a space where access issues and resource-related conflicts can be discussed. This multi-level structure supports conflict resolution and can complement formal interventions by the police.

At the same time, interviewees raised concerns about the effectiveness of this representation system. With more than 1.9 million refugees nationally, representation at the national level is limited to only a small number of individuals, which raises questions about representativeness and whose voices are heard. As UG02 noted, it is challenging for a handful of representatives to meaningfully reflect the diverse interests of refugees who differ by ethnicity, location, and socio-economic position, or to communicate outcomes back to their constituencies. For instance, one stakeholder(UG02 outlined:

> *'Obviously, the refugees have different interests, they have different ethnic composition and their issues will always be very different. That's why I said in terms of capacity, while the intention is very good to discuss these issues, the effectiveness is something that is very debatable' (UG02)*

Synthesis of policy and regulatory environment
(UNITAR & GPA, 2022) define four policy levels, namely global policies (such as the Global

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Compact for Refugees and the SDGS), national and regional policies and frameworks (e.g., national energy policies), sectoral and institutional policies and frameworks (e.g., environmental policies), and humanitarian strategies and frameworks. The interviews with national-level stakeholders, as well as a review of policy documents, has revealed that the policies overlap not only across scales, but also across thematic areas, and oftentimes influence one another. This is summarized in Figure 53.

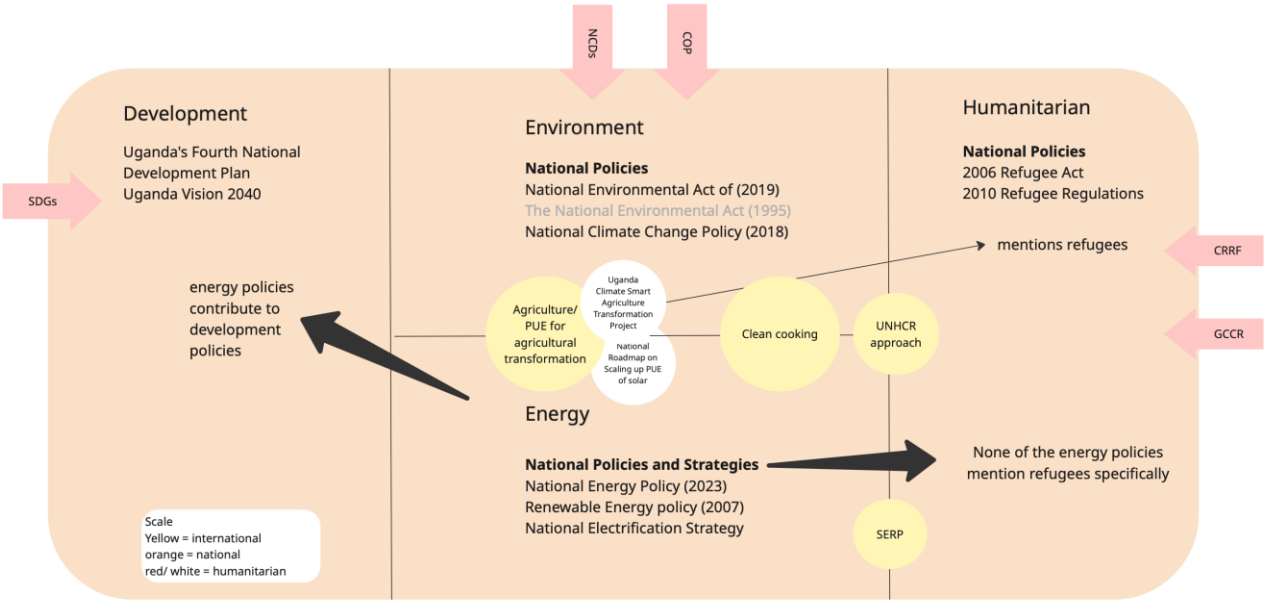

Figure 53: Overview of policies shaping energy access in displacement settings in Uganda across three scales and four thematic areas

Figure 53 summarizes the key energy policies, strategies, and regulations shaping energy provision in Uganda's displacement contexts and host communities[1] - all of which contribute directly to achieving the targets set in Uganda's national development priorities (discussed further below). One policy that interview respondents identified as especially relevant to displacement contexts is Uganda's National Electrification Strategy, which recognizes the role of off-grid solutions and the private sector in extending universal energy access to underserved and hard-to-reach areas (GOGLA, n.d.). Furthermore, a major policy achievement highlighted by all interviewed stakeholders from Uganda is the Sustainable Energy Response Plan (SERP), which consolidates the country's energy policies and frameworks specifically for refugee contexts (discussed further below).

However, a key shortcoming of these energy policies is that they do not explicitly recognize the needs of refugee populations. While sustained lobbying by development

[1] These include the National Energy Policy (NEP, 2023), the Renewable Energy Policy, and the National Electrification Strategy

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and humanitarian organizations has contributed to more inclusive language in the National Energy Policy - referring broadly to 'the population' or 'people living in Uganda' rather than 'citizens of Uganda' - this indirect formulation still leaves room for ambiguity in interpretation (UG03), which can hamper accountability and the allocation of national funds. Indeed, several interviewed stakeholders noted that such ambiguity in energy policy language makes it more difficult to coordinate targeted energy interventions in refugee-hosting areas. Notably, one respondent highlighted that the energy sector lags behind other sectors, such as the Ministry for Water and the Environment, in the extent to which it explicitly recognizes refugees within policy frameworks (UG04), which demonstrates that there is room for improvement that can be achieved through continued lobbying efforts by energy stakeholders.

Environmental policies

Uganda's clean cooking strategy combines regulatory measures with programmatic efforts to reduce reliance on biomass fuels. In June 2023, the *Executive Order No. 3* came into force, which bans commercial charcoal production and the cutting of trees for charcoal and firewood in northern Uganda to curb environmental degradation. Alongside this restrictive approach, the government has also implemented several initiatives to promote clean cooking technologies (J. Ogwok et al., 2022). Notably, the National cooking Strategy seeks to integrate electric cooking into national energy planning and expand access to modern cooking services (Elasu et al., 2025). Our interviews revealed that humanitarian actors were engaged in shaping the policy formulation processes; for instance, UNHCR participated in clean cooking policy discussions, aiming to ensure that refugee considerations are incorporated during detailed policy design (UG04). Moreover, humanitarian organizations are exploring alternatives such as charcoal briquettes, but these remain limited in scale and affordability, constraining their potential to serve as a viable substitute for conventional charcoal (UG02).

However, both primary interview data and existing evidence raise questions about the effectiveness of Uganda's clean cooking policies. In the absence of affordable alternatives, the majority of Ugandan households continue to rely on firewood and charcoal as their primary cooking fuels, undermining the practical impact of the charcoal ban. As one respondent noted, the recently introduced restrictions on forest access place significant constraints on refugee and host populations alike, who 'have to rely on wood energy for cooking' despite formal prohibitions (UG02). Respondents also highlighted a substantial gap between policy and everyday realities, pointing to weak enforcement and widespread continued charcoal use, even among state actors responsible for implementing the ban. One respondent noted:

'But when look at reality, even the police who were supposed to enforce this ban,

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they're using charcoal in their homes. You look at the government who are supposed to enforce this, they are all using charcoal as the main source of energy, especially in the urban areas.' (UG02)

One concrete suggestion to help make cleaner fuels affordable to a broader segment of the population – including refugees – was to introduce more deliberate fiscal policies, such as reducing taxes on liquefied petroleum gas (UG02).

However, the interviews also revealed that while clean cooking remains a central concern, the relationship between environmental protection and refugee populations extends well beyond cooking fuels alone. Respondents highlighted how capacity constraints within refugee governance systems contribute to a range of environmental pressures. For instance, although refugees are allocated land, the population's limited access to adequate construction materials often compels households to rely on surrounding forests for building temporary shelters. Similarly, insufficient latrine coverage in some settlements was identified as a key driver of open defecation, further exacerbating environmental degradation. These examples illustrate that environmental challenges in displacement contexts are not simply the result of individual behaviour, but are closely linked to institutional capacity gaps and the material conditions under which refugees are expected to meet their basic needs.

Development policies

Finally, the provision of energy services in displacement contexts is closely linked to Uganda's main development policies, in particular the Uganda Vision 2030/2040 and the Fourth National Development Plan (NDP V). Energy is identified as a core programme area within the NDP V, reflecting the government's broader ambition to achieve universal access to modern energy services through connecting 100% of the population to the national grid – a vision which is considered applaudable, but out of reach by many stakeholders (UG03, UG04). However, refugees are not explicitly mentioned within the energy section of the NDP V, which creates ambiguity regarding refugees' inclusion and complicates efforts to assess how national energy targets translate into displacement settings (UGG04). Although one respondent explained that the policy's references 'to the population means the refugee plus host communities' (UG03), such implicit references fall short of inclusively addressing energy needs of refugees. One improvement proposed by stakeholders is thus to signal a more deliberate commitment to providing grid access in refugee camps through an explicit acknowledgment of refugees within subsequent development plans.

Reviewing the successes and failures of the Sustainable Energy Response Plan (SERP)

The SERP, formally launched in August 2022, represents Uganda's first comprehensive, government-led framework to guide an improvement of energy access in refugee-

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hosting areas and surrounding host communities (Ministry of Energy and Mineral Development, 2022). The document streamlines humanitarian energy ambitions with national development priorities, and to achieve this aligns closely with the Uganda Vision 2040, the NDP 3, and the National Plan of Action for implementing the CRRF. Developed as a 'medium-term plan' (2022-2025), the SERP was intended to reflect what would be realistically achievable within existing resource and time constraints, while aligning with other sector response plans[2] (Grafham et al., 2022).

The SERP emerged from a multi-stakeholder process initiated by the CRRF Secretariat and led by the Ministry of Energy and Mineral Development (MEMD), with support from the Office of the Prime Minister (OPM), UNHCR, GIZ, the World Bank, and other development partners (Grafham et al., 2022, p. 45). As one interviewee explained, it was conceived as *'a high-caliber document that was supposed establish baseline data, and monitor and guide the implementation'* of energy access projects, with the Prime Minister formally launching the plan alongside senior leadership from the energy ministry (UG03).

The primary aim of the SERP was to consolidate fragmented approaches to energy provision in displacement settings, responding to the challenge that '*energy provision in these settings has historically been fragmented, with different actors promoting conflicting models… which made it difficult to establish coherent, sustainable systems*' (UG03). In response, the SERP promotes a harmonized approach amongst stakeholders, which moves away from in-kind contributions towards service-oriented and market-based energy solutions (Grafham et al., 2022, p. 45).

All interview respondents from Uganda emphasized the significance of the SERP as a policy milestone. One interviewee described it as '*the only real government-led attempt [globally] to mainstream refugee or humanitarian energy access into the line ministry responsible for national energy access*' (UG06), which was rooted in *'a top-down political commitment to integrate displaced populations into Uganda'* (UG06). The significance of this political commitment cannot be overstated, as it responds directly to the bottlenecks and lack of accountability which are hampering the provision of energy services in Uganda's displacement contexts. As one respondent (UG06) explained:

> *'I can't emphasize enough how important [the SERP] is because it enables the partners with the resources and capacity to work on energy to deal with their corresponding line ministry, where they have a mandate and they have access and existing relationships, as opposed to in most countries, the kind of refugee affairs or ministry of home affairs and kind of non-technical, non-line ministry*

[2] particularly the Water and Environment Response Plan and the Jobs and Livelihoods Response Plan

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function. So then then you're not talking the same language. You know, these ministries are just talking in humanitarian terms, and it's disconnected from the from the national energy policy and planning.' (UG06)

Despite broad political endorsement and the recognition of the importance of the SERP amongst all stakeholders, the implementation of the policy is perceived as largely unsuccessful. While interview respondents acknowledged some incremental progress – such as the establishment of regular coordination meetings at both settlement and national levels (UG01) - the policy did not reach the scale or systemic impact originally envisioned. As a result, several respondents questioned the practicality of the SERP as an implementable policy instrument rather than merely a guiding framework (UG01, UG03). The implementation gaps were attributed to a combination of interrelated factors, including limited capacity at local levels, the relative newness of key actors - particularly the Ministry of Energy and Mineral Development - to displacement contexts (UG03), and the highly centralized structure of government, which constrained on-the-ground operationalization.

Several interviewees emphasized that the failure to implement the SERP should not be understood as a lack of commitment or intent, but rather as the outcome of competing institutional priorities and overstretched capacities (UG03, UG04, UG05). There was a recognition that the Ministry of Energy did not take full ownership of the policy, as the SERP was competing for political attention with large-scale, donor-funded national energy programs, limiting its visibility and prioritization within government planning processes. As one respondent outlined:

'A huge energy program was developed at the same time… it's millions of US dollars that is given to the government to implement similar activities… and so having to deal with this very important global player and getting that started… I don't think it was bad intentions from the government' (UG03).

Capacity constraints were further compounded by the fact that engaging in refugee contexts was a relatively new mandate for the Ministry of Energy. As one respondent noted: 'The Ministry of Energy now also working in a refugee context, which was new to them. They didn't have that capacity so much yet. Some people have never been to the refugee context' (UG03). Although Uganda's 'whole-of-society' approach formally requires all line ministries to engage in refugee response, this expectation had not been sufficiently institutionalized. As a result, the coordination structures envisioned by the SERP were never fully operationalized, leaving no dedicated body responsible for driving implementation or monitoring progress. Another respondent therefore argued that 'there is not really someone who is dedicated to do this SERP implementation' identifying weak leadership and accountability as a core challenge (UG04). Others went further,

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suggesting that the SERP was perceived less as a ministry-owned policy than as an externally driven instrument serving the interests of humanitarian actors (UG05).

The uncertainty surrounding the SERP has been further exacerbated by its formal expiration in 2025, with no clear successor policy in place as of December 2025. While informal consultations are ongoing to explore possible next steps, including whether to renew, revise, or merge the SERP with other sector response plans, interviewees noted growing ambivalence about the continued relevance of stand-alone sectoral plans once external funding diminishes (UG03, UG04). At the same time, some stakeholders cautioned against prematurely abandoning the SERP framework. One interviewee warned that without tangible international support and resource mobilization, the political commitment underpinning Uganda's progressive refugee integration approach could erode:

> *'If the international community doesn't help and capitalize and mobilize resources to actually benefit the country in the way that the SERP intends to, then… the pendulum could swing against it and say, 'we've tried that approach, it didn't work'' (UG06).*

Finally, several respondents emphasized that the SERP may simply have required more time to take effect, given the informal and relational nature of policymaking in Uganda. As one stakeholder (UG05) explained,

> *'If SERP is to be successful, you have to sit within government, work around government people within the ministry… it does take time, but gradually through working with government, you can inform the direction of the next project'*

This underscores that beyond formal policy design, sustained engagement, informal influence, and long-term institutional embedding are critical to translating ambitious policy frameworks such as the SERP into effective action.

Analysing the gaps between policy and practice

As touched upon in the analysis above, multiple interviewed stakeholders emphasized the disconnect between Uganda's progressive policy vision and practical implementation of energy services in displacement contexts. This is also reflected in the following interview quotes:

> *'So definitely the legislations are there, but the biggest concern is the implementation. In this country, we always joke about that we have literally every relevant law. The biggest problem is the implementation.' (UG02)*

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'In terms of policy, in terms of legislation… I must commend our country. I think we have done a lot in that aspect. Our biggest challenge is implementation' (UG01).

These implementation gaps are particularly visible in the clean cooking sector, where policies promote modern and low-carbon solutions, while everyday energy practices in refugee settlements and rural contexts more broadly remain dominated by firewood and charcoal. Respondents described the extensive informal economies that have emerged around wood fuel supply, cutting across refugee and host communities alike. One respondent (UG02) described firewood trading as 'a big business', with producers and vendors from across the country benefitting from the sustained demand for biomass fuels in refugee-hosting districts. This informal market persists despite donor- and government-funded programs aimed at promoting tree planting and woodlot development, which seek to reconcile environmental conservation with energy access. While such initiatives support reforestation and soil conservation, they also implicitly acknowledge the continued centrality of firewood as an energy source, highlighting the limited reach of cleaner cooking alternatives.

At the same time, the policy-driven push towards electric pressure cookers illustrates a misalignment between national energy strategies and the infrastructural realities of displacement settings. According to one respondent, refugees are expected to adopt electric cooking solutions despite lacking both the financial means to afford appliances and reliable access to electricity: 'the reality for the refugees [is that] the infrastructure is not there… the grid lines are not there, so they cannot use it' (UG04). Even in settlements nominally connected to the grid, supply is often unstable, requiring diesel generators or solar mini grids as backup systems. This undermines the practicality of electric cooking initiatives and exposes how policy frameworks assume levels of infrastructure reliability and affordability that do not exist in refugee contexts.

Another respondent (UG05) highlighted the gap between energy policies and the electricity access gap in displacement contexts. Whilst Uganda's Rural Electrification Programme articulates ambitious goals to extend electricity access across the country, and in principle, refugee settlements are expected to benefit from these extensions, in practice, settlements remain largely excluded due to resource and capacity constraints, and uneven rollout, which underscores the finding that the implicit inclusion of under-served groups in policy does not automatically translate into energy access on the ground.

One reason for the gap between policy and practice is the limited institutional capacity, which results in both weak regulatory enforcement and prolonged timelines, for instance when it comes to securing approvals. One concrete examples reflecting this is related on the regulations on the quality standards of energy products, such as solar home

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systems and clean cooking solutions. As one respondent (UG01) pointed out, the lack of enforcement of these quality assurance standards directly impacts the social acceptance of solar products in refugee contexts, stating: 'Enforcement is very low. You still see some poor-quality products seeping over to these settlements. So it impacts people's mindset, because if genuine service providers come with these, people just think you are selling counterfeit because they relate these experiences with your product.'

The consequences of these implementation failures extend beyond energy access to environmental degradation and public health risks. Interviewees highlighted how insufficient provision of infrastructure - such as construction materials, sanitation facilities, and modern energy services - forces refugee populations to rely on surrounding natural resources, contributing to deforestation and land degradation. As UG02 explained, when refugees are allocated land without adequate support, 'you can't avoid it… they must look for the trees to go to construct their temporary shelters.' Likewise, the inadequate latrine coverage in Uganda's refugee settlements results in environmental contamination of water. These dynamics underline that environmental impacts attributed to refugee populations are not simply a function of population pressure, but of systemic failures to translate policy commitments into adequately resourced services.

Taken together, these findings demonstrate that the central challenge in Uganda's displacement-energy nexus lies not in the absence of progressive policies, but in the political, institutional, and infrastructural conditions required to implement them. Ambitious targets for electrification and clean cooking coexist with affordability gaps, unreliable infrastructure, weak enforcement, and fragmented governance, raising questions about the feasibility of current policy trajectories. In displacement contexts in particular, the mismatch between policy expectations and lived realities risks entrenching reliance on informal energy systems, undermining both sustainability objectives and refugee self-reliance goals.

Key recommendations to improve energy provision in refugee contexts and host communities in Uganda

- Strengthen implementation capacity at district level by increasing financial, technical, and human resources for local governments responsible for enforcing environmental and energy policies
- Clarify refugee inclusion in national energy and development policies through explicit references to refugees and settlements, reducing ambiguity and improving accountability

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- Further institutionalise the SERP by embedding responsibility within a dedicated government unit and aligning it with core national energy programmes
- Improve coordination across sectors and scales, particularly between energy, environment, and refugee-response institutions, to reduce fragmentation and parallel programming.
- Address affordability through fiscal and financial instruments, including targeted subsidies, reduced taxation on clean fuels (e.g. LPG), and financing mechanisms that are accessible to refugee and host populations.
- Prioritize realistic technologies in national clean cooking strategies, ensuring that policy ambitions (e.g. e-cooking) align with low grid access and low household purchasing power amongst refugees and host communities
- Invest in refugee representation and feedback mechanisms, strengthening the capacity of refugee leadership structures to communicate across scales and represent diverse interests.

3.3. Findings for Rwanda

Rwanda's national energy policy and regulatory environment is generally enabling for energy provision, particularly for clean cooking, solar home systems, and productive use of energy. However, refugee settings are not systematically integrated into national electrification or energy access planning, resulting in a gap between Rwanda's progressive national energy ambitions and their practical application in displacement contexts. Refugee camps are excluded from grid expansion plans and treated as temporary spaces, which limits the government's longer-term infrastructure investments in the camps despite the protracted nature of displacement (RW01). This is particularly striking given that Rwanda has hosted refugees for more than two decades and, by mid-2022, accommodated nearly 127,000 refugees - mainly from the Democratic Republic of the Congo and Burundi - across five refugee camps[3] (Grafham et al., 2022).

Environmental protection emerged as a central driver of the Rwandan government's approach to hosting refugee populations and has significantly shaped energy provision in displacement contexts. Interview respondents highlighted that the government is particularly concerned about deforestation and environmental degradation around refugee camps, driven by widespread reliance on biomass for cooking, which can intensify competition over natural resources and exacerbate tensions with host communities (RW05). These concerns underpin Rwanda's commitments to promote clean energy solutions and rehabilitate refugee-hosting areas, stated at the Global Refugee Forum in 2019 (Grafham et al., 2022). However, despite these pledges, refugee

[3] Kigeme, Kiziba, Mahama, Mugombwa and Nyabiheke

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populations remain only partially recognized within Rwanda's national energy and environmental policies, demonstrating a gap between international and national policy approaches. In this sense, energy access in refugee settings is framed less as a welfare issue and more as a tool for environmental protection and social stability.

Moreover, whilst Rwanda has several key financing mechanisms to expand national access to clean energy - such as results-based financing, carbon credit schemes, and donor-backed programs - refugee camps are often excluded from these instruments. National funding streams and carbon finance mechanisms typically do not apply to humanitarian contexts, limiting access to capital for companies working in camps (RW01). This further reinforces reliance on NGOs and international agencies and creates a structural gap between national energy policy frameworks and the realities of energy provision in displacement settings. However, one stakeholder (RW02) explained that although the Rwandan government lacks the funding to support energy provision for refugees, it does not block other actors – such as NGOs – from engaging in this field.

Governance

At the national level, several key stakeholders are involved in the governance of energy provision in displacement contexts, as illustrated in Figure 54. MINEMA and UNHCR function as the main entry points for energy projects in refugee settings and maintain a coordinated working relationship. MINEMA has no dedicated energy expertise, and energy initiatives are often subsumed under 'livelihoods' programming rather than integrated into national energy planning frameworks (Grafham et al., 2022). There is thus a disconnect between national energy policies - largely overseen by the Ministry of Infrastructure (MININFRA) - and the governance of refugee camps, which falls under the Ministry of Emergency Management (MINEMA).

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Figure 4. Humanitarian energy policy landscape in Rwanda

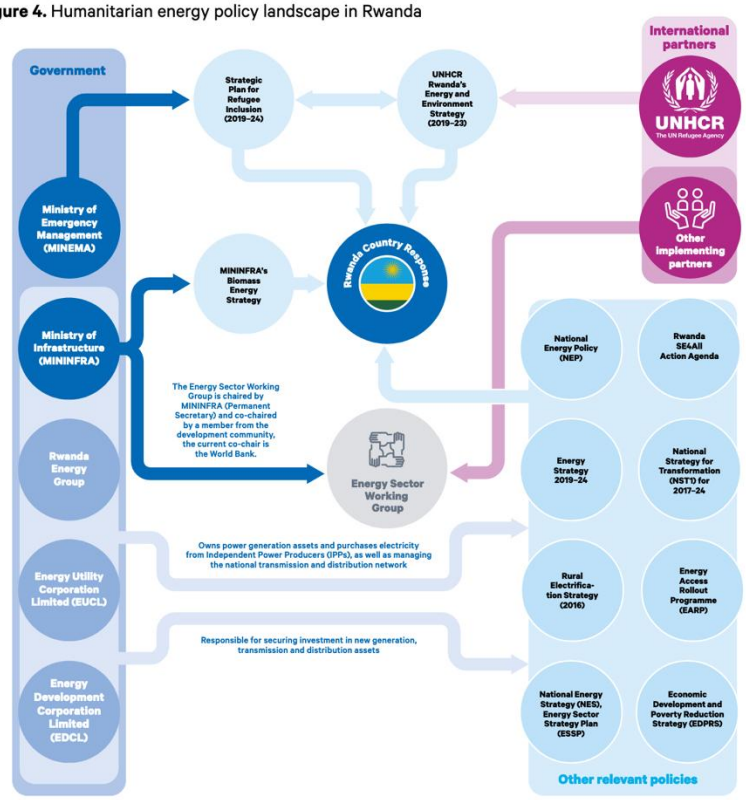

Figure 54: Humanitarian energy policy landscape in Rwanda (Grafham et al., 2022)

The interviews gave an in-depth insight into the pathways of collaboration amongst the different types of stakeholders (humanitarian actor, government, development actor, private-sector actor) involved in energy provision in Rwanda's displacement contexts. Whilst all stakeholders agreed that collaboration is essential for their work, they also characterized the existing coordination as fragmented, resulting in largely ad hoc interventions driven by individual organizational mandates rather than an integrated policy framework (RW02, RW05). The respondents felt that this was due to broader governance challenges, including a crowded landscape of actors with divergent priorities, limited funding, and the absence of a shared strategic vision across agencies (RW05). Implementing organizations emphasized that formal cooperation with UNHCR, MINEMA, and district authorities is a prerequisite for operating in camps, which is typically achieved through MoUs (RW04). In practice, however, engagement with national ministries often occurs only when required for specific project components - such as grid connections involving the Rwanda Energy Group - rather than through sustained, strategic coordination (RW02).

District governments were widely viewed as key enablers of energy provision in displacement contexts (RW02, RW03). Amongst other responsibilities, district governments control the allocation of land in refugee contexts and are thus a key factor enabling the implementation of mini grids. Moreover, if NGOs are planning an energy

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intervention that can legally be connected to the national grid – such as a healthcare facility or a business centre – the district government is the connecting link between the implementing partner and the energy regulatory authority (RW02). As a result of this central role, RW02 saw district governments not only as an enabler, but as a key project partner.

Furthermore, the interviews revealed that energy access in Rwanda's refugee camps largely operates through humanitarian systems rather than national energy markets or governmental provision. For instance, free LPG provision (coordinated by UNHCR) represents the main formal clean cooking intervention, but quantities have been reduced over time and are increasingly insufficient to meet household needs. On the other hand, access to camps is tightly regulated by both the government and UNHCR actors, which disincentivizes private-sector actors from providing energy services in displacement settings, thereby hampering a shift to market-based approaches. This leads to a tension between humanitarian and development approaches to enhancing energy access for refugee populations, which was discussed by several stakeholders (RW02, RW05).

Figure 55**Error! Reference source not found.** conceptualizes this tension by illustrating the three key policy 'pillars' on which the provision of energy access in Rwanda rests. A humanitarian–development continuum was chosen to highlight the coexistence of different approaches rather than a linear transition between them. At one end, the life-saving mandate reflects the humanitarian paradigm which informs the work of UNHCR and other humanitarian actors. As part of this mandate, energy access is treated as secondary to immediate survival needs, such as food and shelter (Rosenberg-Jansen, 2025). Consequently, actors working under this approach focus on the short-term provision of basic energy products, such as LPG or solar lamps, through limited free distribution. However, this approach is limited in its effectiveness, as the distribution of in-kind contributions is severely hampered by funding uncertainty and short planning horizons.

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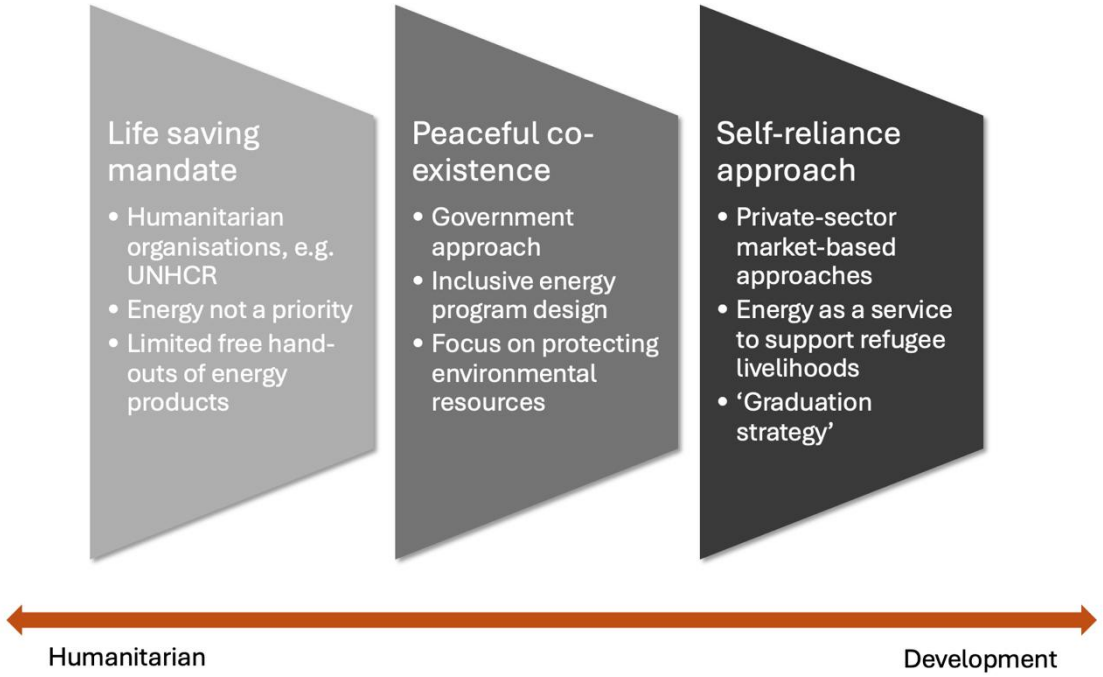

Figure 55: Continuum of humanitarian and development approaches to energy provision in displacement contexts

Moving along the continuum, the peaceful co-existence approach reflects Rwanda's hybrid model, where energy access is increasingly framed as a tool to mitigate environmental degradation and reduce tensions between refugees and host communities, aligning humanitarian action with national priorities on environmental protection. This approach is reflected, for instance, in the Refugee Component of the Civil Peace Service of the GIZ (CPS/GIZ), who published a comprehensive evaluation of the 'dynamics of the relationships among refugees, between refugees and host communities, and with organizations working in the camp' in Mahama in 2017 (Rubli, 2017).

At the development-oriented end, the self-reliance approach emphasizes market-based and private-sector-led energy services to support refugee livelihoods and economic integration, which is rooted in the Global Compact for Refugees and is reflected in initiatives such as Renewable Energy 4 Refugees (RE4R)4. However, implementation remains uneven due to affordability constraints, regulatory barriers, and limited purchasing power. Overall, the graphic captures a central tension in Rwanda's

[4] UNHCR & PA works with refugees and their host communities to access finance, training, technology and expertise to improve access to renewable energy. By powering homes, schools, health clinics and businesses, the project enables refugees to flourish and move from reliance on aid to economic independence.

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displacement context: while policy discourse increasingly promotes self-reliance, energy provision continues to be shaped by overlapping mandates and humanitarian constraints, underscoring the need for better alignment between humanitarian, national, and market-based approaches.

Overview of policy and regulatory environment

The following paragraphs outline the main insights gained from the stakeholder interviews with regards to key policies in four thematic areas - Refugee response, energy policies, clean cooking and environmental policies – the latter two of which were recognized as especially influential by multiple stakeholders (RW03, RW04, RW06).

Refugee policies

Rwanda's refugee policy framework is formally anchored in international standards and national commitments to inclusion. As a signatory to the 1951 Refugee Convention and its 1967 Protocol, as well as the Global Compact on Refugees, Rwanda provides refugees with legal protections and access to national services such as healthcare, education, civil registration, and, in principle, socio-economic and financial services, including the right to work and to open bank accounts (Law n°042/2024). However, as one stakeholder (RW05) noted, in practice the national approach to refugees is 'more exclusive'. However, the same stakeholder also outlined that he perceived that at least some governmental stakeholders had recognized the value in taking a more inclusive approach to refugee populations, thereby suggesting that humanitarian policies in Rwanda could be further evolving. Specifically, they believed that this could contain an economic advantage for the country[5], arguing:

> *'The camps have micro-economies, and they could be incorporated into national economy, so the Rwandan government could be taxing these businesses and allowing them to participate in the local economy. There is a plan in the government to transition from camps into settlements, similar to what happened in Kenya, but it is difficult to deliver this in practice' (RW05)*

Energy policies

Rwanda's national energy policy framework is widely considered to enable energy access, with benefits extending to displacement contexts to some extent, even though refugees are not prioritized in implementation and are not actively recognized in all policies (RW02, RW04, RW06). Rwanda's energy policy is embedded within a wider development vision centred on green growth and development, as articulated in Rwanda's Vision 2050, the National Strategy for Transformation (NST-1), and the Green Growth and Climate Resilience Strategy (GGCRS). These frameworks position energy as

[5] See Rwanda's Strategy for the Economic Inclusion of Refugees (2016–2020)

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a key enabler of socio-economic transformation, with particular emphasis on electrification, clean cooking, and the productive use of energy (PUE) to support income generation (National Policy Review Rwanda, 2022).

Rwanda has pursued an ambitious electrification agenda through a combination of grid expansion and off-grid solutions[6], supported by the Energy Sector Strategic Plan and the country's rural electrification strategy. However, stakeholders noted persistent challenges in the provision of energy services for refugee populations, including limited household-level electricity provision in camps and the absence of government subsidies for camp-based end-users. As a result, international donors and NGOs often step in to provide demand-side subsidies, which reinforces a reliance of refugee populations on external actors (RW02).

Overall, the policy environment can thus be characterized as passive yet permissive. While refugees are not systematically integrated into national energy access strategies, the regulatory framework does allow NGOs and private companies to deploy solar home systems and mini grids in or near refugee camps. As one stakeholder noted:

> *'Certainly, the government is not blocking attempts by the rest of the sector to get solar home systems adopted and like, yeah, I think that I think it does form at least at least a permissive and enabling kind of environment for these things to happen.' (RW02)*

In response to this gap, stakeholder RW06 highlighted the need to continue the advocacy for refugee rights, so that in the future refugee populations will be explicitly acknowledged in Rwanda's energy policies. However, they also noted that even when refugees are included in official documents – such as the manual for the ASCENT program by the World Bank – this does not necessarily translate into inclusion the implementation.

Finally, while Rwanda's regulatory environment includes differentiated electricity tariffs and fiscal instruments intended to promote clean energy technologies, there remain notable barriers for private-sector companies to enter displacement contexts. Gaining exemptions for import duties on appliances and energy equipment, for instance, remains difficult and time-consuming, which tends to disadvantage smaller or newer actors in the off-grid sector (RW02). Overall, Rwanda's energy policies reflect strong political commitment and institutional coherence, but their impacts in displacement settings remain shaped by affordability constraints, reliance on humanitarian actors,

[6] As of 2022, over 70% of households had access to electricity, with off-grid solar playing a central role in reaching remote and low-income populations (National Policy Review Rwanda, 2022).

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and incomplete integration of refugees into national energy access programs.

Clean cooking

Rwanda's clean cooking policies were identified by almost all stakeholders as the most influential factors shaping energy provision in refugee contexts (RW01, RW04, RW05, RW06). At the core of this policy landscape are the Rwanda Energy Policy and the Energy Sector Strategic Plan (ESSP), which explicitly aim to reduce reliance on traditional biomass fuels and promote cleaner cooking technologies, including improved biomass stoves, LPG, biogas, and electricity (H. Njiru Nyaga et al., 2021). These ambitions are further operationalized through the Biomass Energy Strategy and Rwanda's updated Nationally Determined Contributions, which set targets to substantially reduce biomass dependence and scale up improved and clean cooking solutions nationwide.

Through these policies, Rwanda has adopted strict national standards, including a strong push toward Tier 3 and above cookstoves, enforced through certification and quality assurance mechanisms. While this reflects ambitious health and environmental objectives, one stakeholder (RW01) outlined the issues that have emerged from having such ambitious policies, as these standards unintentionally exclude low-income households by limiting access to incremental transitions (e.g. Tier 1 to Tier 2). This is an issue particularly in refugee areas, where affordability is already extremely constrained, and subsidies are typically not available (see above) (RW01). Therefore, these policies lead to exclusionary energy provision and create additional barriers which are likely to reinforce dependence on donor-funded programs rather than market-based provision.

However, stakeholders emphasized that Rwanda's clean cooking policy is not static but 'keeps evolving' in recognition of these affordability challenges, in addition to issues with the reliability of supply chains, and the need for behavioural change (RW04). Nevertheless, the interviews revealed that gap between refugee and host populations persists, as existing policies prioritize citizens' access to clean cooking technologies (RW05). This creates a gap between the national objective to move away from biomass and towards clean cooking technologies, and the realities of refugee populations who cannot access nor afford such technologies and reflects the inherent tension between national sustainability transitions and inclusive, local resource allocation.

In response, the provision of free LPG by UNHCR has been a central intervention to advance clean cooking, particularly in camps such as Mahama. This support typically involves the free distribution of 6 kg LPG cylinders, with refill frequency determined by household size and vulnerability category (RW02). Only households classified in the most vulnerable categories are eligible, reflecting a broader policy of socio-economic stratification and means-testing that governs refugee assistance and has significant implications for energy access (RW02). While this intervention has enabled some

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households to reduce reliance on firewood and charcoal, stakeholders highlighted that the quantity of LPG provided is often insufficient to meet daily cooking needs, forcing households to revert to fuel stacking with charcoal, pellets, or collected firewood (RW02).

One challenge that impacts both refugee and host communities is that clean cooking is often aspirational, with decisions shaped by affordability constraints and competing household needs such as food security and education expenses. In response, there have been some government-led awareness-raising initiatives to promote clean cooking technologies in Rwanda, including in refugee-hosting areas (RW02). These efforts seek to increase acceptance of improved cookstoves and modern fuels by highlighting health, environmental, and efficiency benefits, and align with national policy emphasis on behavioural change campaigns as a necessary component of the clean cooking transition (H. Njiru Nyaga et al., 2021). However, awareness-raising was not considered sufficient to shift cooking practices in refugee camps without parallel interventions that reduce costs and address structural economic barriers. (RW02).

Taken together, these findings suggest that while Rwanda has a comparatively coherent policy framework for clean cooking, its translation into refugee camp contexts remains partial. Free LPG provision plays a critical short-term role but is likely to be phased out due to UNHCR's funding constraints, whilst awareness-raising initiatives support policy objectives but cannot compensate for affordability gaps. Advancing access to clean cooking in refugee camps therefore requires an integrated approach that aligns national policy instruments and humanitarian energy provision with local livelihood strategies.

Waste management policies

Finally, one identified policy area that remains underdeveloped in Rwanda's refugee contexts is waste management, with particularly acute gaps around the handling of electronic waste (e-waste). One interviewee (RW04) highlighted that waste management systems in camps are rudimentary, with all waste being mixed and disposed of at open dumping sites, without recycling or safe treatment. Whilst Rwanda has made progress in terms of handling e-waste in urban centres, reflected in the establishment of the Nduba landfill and national e-waste recycling facilities, these systems have not systematically been extended to rural areas *'there is no policy tackling waste, especially in the camps' (RW04).* As a result, damaged solar home systems, appliances, and household electronics accumulate or are discarded alongside general waste, posing environmental and health risks.

This gap reflects a broader disconnect between national waste and e-waste policies - such as Rwanda's e-waste management regulations and emerging Extended Producer Responsibility (EPR) frameworks - and their application in refugee contexts, which are excluded from long-term infrastructure planning. Stakeholders also pointed to the

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absence of guidance on after-sales services, take-back schemes, and user awareness, noting that many residents lack knowledge of how or where to dispose of broken electronic equipment (RW04). Thus, despite Rwanda's focus on environmental governance, the country's policy framework has yet to adequately address e-waste in refugee camps.

Gaps between policy and practice

A first key gap between policy and practice concerns the translation of Rwanda's enabling policy environment into effective implementation on the ground. While national frameworks formally allow private-sector and development actors to operate in refugee camps, in practice access restrictions significantly delay or constrain project implementation, even for well-established organizations (RW02). These restrictions - often justified on safeguarding or security grounds- limit the ability of energy providers to install, maintain, or scale up services in camps and reinforce a fragmented governance landscape.

A second key gap identified by stakeholders was the weak coordination among actors involved in energy provision, with projects frequently developed in isolation rather than as part of a shared strategy. As a result, energy interventions tend to be piecemeal and inefficient, despite the existence of multi-stakeholder platforms and stated commitments to more integrated approaches. Here, an integrated sector approach similar to the one taken by the Ugandan government (See Section 'Reviewing the successes and failures of the Sustainable Energy Response Plan (SERP)) could be a solution to closing the policy-practice gap.

A third gap relates to affordability challenges, leading to unequal access to energy services within camps. National energy policies prioritize higher-tier technologies and market-based delivery models, yet these remain largely inaccessible to low-income refugee households, who are excluded from national subsidy schemes because they are not registered in national social protection systems. This exclusion results in a second, related gap between policy and practice: Whilst the government's clean cooking policies aim to eliminate all cooking technologies below tier-3, refugee populations in reality cannot use these higher-tier technologies because they require a level of electricity that is typically only provided to grid-connected households, yet the majority of refugee households remain without formal electricity access (RW02).

A final identified gap exists between the ambition to integrate refugees into the local economy and the regulatory hurdles that refugee-led businesses face. These include, for instance, national standards and certification requirements, which restrict their ability to sell locally produced energy technologies - such as improved stoves or briquettes - beyond the camp without undergoing costly testing and compliance

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processes (RW04). Although refugees are formally permitted to work and engage in economic activities under Rwanda's Comprehensive Refugee Response Framework, these regulatory barriers limit the scalability of refugee enterprises and undermine policy ambitions around self-reliance and market integration.

Key recommendations to improve energy provision in refugee contexts and host communities in Rwanda

- Systematically integrate refugee settings into national energy planning to improve accountability. Treating camps as temporary spaces undermines long-term infrastructure investment despite protracted displacement.
- Extend national financing and subsidy mechanisms to displacement contexts. Exclusion from national social registries currently prevents refugees from accessing support for higher-tier technologies, reinforcing dependence on humanitarian aid and limiting market-based solutions.
- Strengthen coordination and clarify institutional responsibilities. Assigning dedicated energy expertise within MINEMA and establishing more strategic, long-term coordination platforms would reduce fragmentation and improve policy implementation.
- Enable private-sector engagement through improved camp access and regulatory reform to reduce implementation delays in displacement contexts.
- Address affordability constraints through targeted, context-sensitive interventions. Clean cooking and electricity policies should better account for the limited purchasing power of refugee households through supporting incremental technology transitions, combining awareness-raising with affordability measures, and avoiding exclusive reliance on high-tier standards that unintentionally exclude low-income users.
- Develop a dedicated waste and e-waste management strategy for refugee camps
- Strengthen advocacy to close the policy–practice gap to ensure that formal inclusion of refugees in policy documents translates into implementation.

4. Results: Desk Review

The desk review generated a broad and detailed body of findings on the policy, regulatory, and institutional environment shaping energy access in displacement contexts in Rwanda and Uganda. To maintain the readability and overall balance of the main deliverable, these results are therefore not presented here in full but are documented in a separate dedicated report accompanying Deliverable D1.1. Presenting the desk review findings in a stand-alone document allows the main deliverable to

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provide an overview of the regulatory and policy analysis, while giving interested readers access to the full evidence base, including the structured mapping of relevant frameworks and the more detailed analytical discussion. The separate report focuses specifically on the regulatory, policy, and institutional dimensions of energy access and does not assess market demand, affordability, willingness to pay, or financial viability, which are addressed elsewhere in the project.

The dedicated desk review report is structured in two main parts. First, it provides a comprehensive overview of the global, humanitarian, regional, and national policy and regulatory frameworks relevant to energy access in displacement contexts and host communities, including those of relevance to the SUNNY technology areas as well as larger-scale energy systems such as national grids and mini-grids. Second, it presents an analytical section on energy policies and regulations in Rwanda and Uganda. This analytical part is organised around four main themes: the evolution of regulatory frameworks and policies on energy provision in displacement contexts; the current policy and regulatory landscape, including key enabling factors and persisting gaps; the regulations and policies governing market-based approaches to energy provision; and the future outlook. Across these themes, the report combines discussion of global policy developments with country-specific analyses for Rwanda and Uganda and includes synthesis sections to support comparison across the two contexts.

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VII. SUMMARY AND OUTLOOK

SUMMARY

Deliverable D1.1 brings together the results of SUNNY Task 1.1 to establish a comprehensive contextual understanding of energy access in refugee and host communities in Uganda and Rwanda. This understanding is developed through four complementary analytical components: the system-centred description, the person-centred analysis, the environmental analysis, and the regulatory and policy analysis. Taken together, these components show that energy access in displacement contexts must be understood not only in technical terms, but also in relation to local socio-economic conditions, community perspectives, environmental resource potentials, and the policy and institutional frameworks that shape implementation. In this way, the deliverable provides an integrated evidence base for the subsequent design, tailoring, and assessment of SUNNY solutions.

The deliverable package consists of the main document and three accompanying stand-alone documents: the Uganda context survey results report, the Rwanda context survey results report, and a dedicated desk review report on the regulatory and policy analysis. The main document synthesises the overall analytical framework and key findings, while the additional documents provide the detailed survey and desk-review results. Across these different parts, several overarching findings emerge. First, the system-centred and person-centred components show that access to energy services is closely intertwined with wider livelihood conditions, local infrastructure, and differences between refugee and host communities. Second, the survey and workshop results underline the central importance of affordability, financial means, safety, knowledge, and support structures in shaping whether households can access and use energy services in practice. Third, the environmental analysis highlights that current waste management conditions create significant environmental and health challenges, while also pointing to opportunities for circular approaches such as composting and biogas production from concentrated biowaste streams. Fourth, the regulatory and policy analysis shows that both countries provide important entry points for sustainable energy interventions, but that persistent barriers remain, particularly institutional fragmentation, regulatory uncertainty, affordability gaps, and the still limited integration of displacement contexts into national energy planning frameworks.

The main outputs of Deliverable D1.1 are therefore a multi-dimensional contextual evidence base, a structured synthesis of the demonstration contexts, detailed country-specific survey results, a dedicated regulatory and policy desk review, and additional workshop outputs documented in the annexes, including handouts developed as part of

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the participatory process. Together, these outputs provide the foundation for subsequent SUNNY activities by informing solution design, use-case definition, stakeholder engagement, circularity-related assessments, monitoring activities, market-related analysis, and future policy recommendations.

OUTLOOK

The results of Deliverable D1.1 provide a key foundation for the next phases of the SUNNY project. Above all, they will be used to ensure that subsequent project activities are grounded in a detailed understanding of the local contexts in Uganda and Rwanda. The findings will inform the design, adaptation, and implementation of SUNNY solutions by clarifying the social, technical, environmental, and regulatory conditions within which these solutions will operate. In this way, the deliverable supports the definition of use cases, the refinement of requirements, the planning of demonstration activities, and the identification of context-appropriate implementation pathways. The results will also contribute to stakeholder engagement, market-related analysis, circularity-related assessments, and the development of policy recommendations, thereby helping to connect the contextual analysis undertaken in Task 1.1 with the subsequent technical, practical, and strategic work of the project.

At the same time, Deliverable D1.1 provides an important basis for continued scientific work within SUNNY. In addition to the publication that has already been produced, the results generated through the different components of the deliverable will serve as a foundation for further scientific publications.

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ANNEX

ANNEX 1: HANDOUT FOLLOWING WORKSHOP : WORKSHOP IN BIDIBIDI REFUGEE SETTLEMENT

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Handout for Workshops

Descriptive information

- Dates: 19.06.2024; 21.06.2024; 22.06.2024
- Location: Bidibidi Settlement, Zone 1
- Organized by: CTEN, TU Berlin, Hudara
- Workshop participants: representatives of the refugee and host communities

Objective of the workshop

- The main objective of the workshop was to capture different perspectives on the relevance of energy in the daily lives of the members of the host and refugee communities.
- One key element of the workshop was the focus on developing concept ideas and discussing open question together. We refer to this as participatory research.
- The learnings of the workshop will be directly applied to in the development of a survey that will be conducted in the refugee and host community.
- One additional objective of the workshop was to introduce the SUNNY project.

Format and content of the workshop

- The format of the workshop designed in such a way that many groups within the community can be represented. As part of the workshop, we conducted different kind of activities. The activities included sessions in which we collaboratively discussed different topics, and the workshop included sessions during which participants reflected on a question themselves.
- As part of the workshop, we discussed:
    - rules that are important to follow in research
    - the relevance of energy in daily lives
    - the concept of energy services
    - challenges with energy products

Guidelines in research

As part of the introduction, we discussed two important concepts regarding the rules for conducting research: (1) voluntariness and informed consent, and (2) confidentiality

(1) voluntariness and informed consent:

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- We discussed that it is up to every person to decide for themselves whether they want to participate in the workshop. It is important that all participants can decide to no longer participate in the workshop at any point in time and no reason needs to be stated.
- It is important that participants understanding the purpose of the research, and how the collected data will be used. Participants gave their informed consent.

(2) confidentiality:

- It is important to know that all information that the research team is noting down will be stored in a safe place and no personal information will be shared with anyone outside the research team.
- It is important to ensure the privacy and confidentiality of participants and the participant's private information.

Overview of the input: energy and energy services in the daily life

- In a workshop session we discussed the topic of energy.
- There are many different forms of energy. Examples of forms of energy include energy from the wind, biomass (e.g., firewood), solar energy, and electricity.
- Depending on the form of energy, the energy can be used for a different activity. We describe using a form of energy for a useable outcome for an activity as an "energy service".
- Example: The activity "cooking" is an energy service, because the activity is made possible by using a form of energy. The energy service "cooking" can be achieved by using a variety of forms of energy, such as firewood, briquettes, electricity, gas, charcoal.

				
Form of energy		Energy service: Cooking		Cooked meal

- As part of the workshop, we discussed a long list of energy services that exist. We discussed challenges and opportunities of different energy services.

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- Also discussed the availability, the challenges and the opportunities of various energy products. Energy products are products that are associated with the use of energy, such as solar panels, lamps, batteries, and cookstoves. There are many more examples for energy products.

			
Form of energy	Firewood	briquettes	charcoal
Energy services (examples)	Cooking, heating	Cooking, heating	Cooking, heating

			
Form of energy	Diesel and petrol	Electricity from solar	Electricity from the grid
Energy services (examples)	Transportation	Lighting, phone charging	Lighting, phone charges

In the workshop we discussed:

- The availability of **energy sources** and technologies, such as solar energy, clean cooking stoves, and efficient lighting systems. This helps ensure access to energy for cooking, heating, and lighting in camps where traditional sources may be scarce or expensive.
- The use of **renewable energy and efficient energy practices**, reducing the reliance on firewood and fossil fuels, which can lead to deforestation and environmental degradation around refugee settlements.

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Following the workshop:

- The workshops were conducted as part of the SUNNY project. The learnings from the workshop will be integrated into the design of a large-scale survey. The purpose of the survey is to get an even better understanding of the energy situation in the host and refugee communities. The learnings from the workshop and the survey will be applied to improve energy technologies and energy systems, some of which will be implemented as part of the SUNNY project.
- Once the research into the energy situation is concluded, results will be accessible.

Interim results from the workshops:

- In the workshop we developed lists of energy services, energy technologies and energy services that are available in the communities. The following tables was developed based on the contributions from the workshops participants.

Category	Energy service	Energy services accessed through technology and or energy source
COOKING AND HEATING	cooking	firewood (includes using mud stoves and energy saving stoves)
		charcoal (includes mud stoves and energy saving stoves)
		kerosine
		biogas
		solar
	heating or boiling water	
LIGHTING	lighting in homes	firewood
		solar
	lighting of communal areas and facilities	solar
APPLIANCES AND LIVELIHOOD	using and charging phones	solar
		power banks
	charging of tables, and speakers	electricity

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	using radios	solar
		dry cell
	playing music	electricity
	using electricity for appliances	not specified
	using printing, photocopying, computer services	generator
	using electricity to access the internet	
	using electricity for information and communication	
	using fridge for cooling drinks and fruits	generator
	using appliances powered by batteries	dry cell batteries
	using machines that run on diesel, such as grinding machines	diesel
	operation of hair saloon	solar
	operation of sewing machines	
	Drying of agricultural products (grass, cassava, maize, etc.)	utilizing the sun
	Access to electricity for businesses	solar
	using electricity for welding	
	using electricity for tailoring services	
	using electricity from hydropower	
TRANSPORT	transportation	Fuel/petrol
	transportation of goods and food products	
	transportation of people (motor vehicles and bikes)	

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COMMUNCAL FACILITIES	water supply	motorized (solar)
	irrigation system	
	Space cooling at communal facilities	
	technical devices in health facilities	

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ANNEX 2: HANDOUT FOLLOWING WORKSHOP: WORKSHOP IN MAHAMA REFUGEE CAMP

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Handout for Workshops

Descriptive information

- Dates: 27.06.2024, 28.06.2024, 02.07.2024, 03.07.2024
- Location: Mahama
- Organized by: Practical Action, CTEN, TU Berlin, Hudara
- Workshop participants: representatives of the refugee and host communities

Objective of the workshop

- The main objective of the workshop was to capture different perspectives on the relevance of energy in the daily lives of the members of the host and refugee communities.
- One key element of the workshop was the focus on developing concept ideas and discussing open question together. We refer to this as participatory research.
- The learnings of the workshop will be directly applied to in the development of a survey that will be conducted in the refugee and host community.
- One additional objective of the workshop was to introduce the SUNNY project.

Format and content of the workshop

- The format of the workshop designed in such a way that many groups within the community can be represented. As part of the workshop, we conducted different kind of activities. The activities included sessions in which we collaboratively discussed different topics, and the workshop included sessions during which participants reflected on a question themselves.
- As part of the workshop, we discussed:
    - rules that are important to follow in research
    - the relevance of energy in daily lives
    - the concept of energy services
    - challenges with energy products

Guidelines in research

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- It is important that participants understanding the purpose of the research, and how the collected data will be used. Participants gave their informed consent.

(2) confidentiality:

- It is important to know that all information that the research team is noting down will be stored in a safe place and no personal information will be shared with anyone outside the research team.
- It is important to ensure the privacy and confidentiality of participants and the participant's private information.

Overview of the input: energy and energy services in the daily life

- In a workshop session we discussed the topic of energy.
- There are many different forms of energy. Examples of forms of energy include energy from the wind, biomass (e.g., firewood), solar energy, and electricity.
- Depending on the form of energy, the energy can be used for a different activity. We describe using a form of energy for a useable outcome for an activity as an "energy service".
- Example: The activity "cooking" is an energy service, because the activity is made possible by using a form of energy. The energy service "cooking" can be achieved by using a variety of forms of energy, such as firewood, briquettes, electricity, gas, charcoal.

				
Form of energy		Energy service: Cooking		Cooked meal

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- Also discussed the availability, the challenges and the opportunities of various energy products. Energy products are products that are associated with the use of energy, such as solar panels, lamps, batteries, and cookstoves. There are many more examples for energy products.

			
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Energy services (examples)	Cooking, heating	Cooking, heating	Cooking, heating

			
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Energy services (examples)	Transportation	Lighting, phone charging	Lighting, phone charges

In the workshop we discussed:

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- The use of **renewable energy and efficient energy practices**, reducing the reliance on firewood and fossil fuels, which can lead to deforestation and environmental degradation around refugee settlements.

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Following the workshop:

- The workshops were conducted as part of the SUNNY project. The learnings from the workshop will be integrated into the design of a large-scale survey. The purpose of the survey is to get an even better understanding of the energy situation in the host and refugee communities. The learnings from the workshop and the survey will be applied to improve energy technologies and energy systems, some of which will be implemented as part of the SUNNY project.
- Once the research into the energy situation is concluded, results will be accessible.

Interim results from the workshops:

- In the workshop we developed lists of energy services, energy technologies and energy services that are available in the communities. The following tables was developed based on the contributions from the workshops participants.

Category	Energy service	Energy services accessed through technology and or energy source
COOKING AND HEATING	cooking in the household	LPG
		charcoal
		firewood
	heating water (for drinking, washing etc.)	firewood
		LPG
LIGHTING	lighting	household lighting (SHS)
	outside lighting	torch
		phone solar lantern
	public lighting	
	lighting for a business	
APPLIANCES AND LIVELIHOOD	Listening to the radio	

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	using a phone (communication and paying for services)	
	charging a phone	solar
	charging power bank	
	charging of devices	
	playing music	
	watching TV	
	Cooling and Freezing of	fridge and freezer for cooling or freezing fruits, vegetables and animal products (e.g., milk)
		fridge for cooling water and drinks
		fan
	electricity	solar panels
		SHS
		grid
	using electrical devices	
	pressing of clothes	flat iron
	ironing of clothes	charcoal iron
	using the internet	
	sewing	sewing machine
	shaving	
	Drying (e.g., beans, sorghum, maize, soja, groundnut)	utilizing the sun
	operation of machines for production processes	
	electricity for the operation off a business	
	using photocopying services	
	using laptops (e.g. for payment services)	
TRANSPORT	transportation of persons and goods	motorcycle or boda-boda (petrol)
		bus
COMMUNCAL FACILITIES	water supply	motorized
	water irrigation system	water sprayer and

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tank

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ANNEX 3: RESEARCH ARTICLE : ASSESSING BIO WASTE FLOWS, REUSE PRACTICES AND VALORISATION OPPORTUNITIES IN BIDIBIDI REFUGEE SETTLEMENT AND ITS HOST COMMUNITY IN THE YUMBE DISTRICT, UGANDA

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